A SKETCH

OF THE

GEOLOGY, MINERALOGY, &c.

OF THE

CONNECTICUT.

PART I.

The region embraced by the accompanying map, and to which this sketch is principally confined, is about 150 miles long and 30 broad; extending from New-Haven to Bellows' Falls. A leading object of this map is to give an accurate view of the secondary tract extending from New-Haven 110 miles northerly to Northfield. But it is protracted 30 or 40 miles beyond this, on the north, so as to embrace probably all the argillite along this river. A considerable extent of primitive is also exhibited on the borders of the secondary. The map is not colored according to the Wernerian distinctions of primitive, transition and secondary; nor according to Macculloch's division of rocks into unstratified and stratified: but an attempt has been made to give every particular rock that position and extent on the map which it actually occupies on this portion of the earth's surface. Every geologist knows, that perfect accuracy in these respects, on a map of such extent, would require a degree of labour and research, which, none but those whose whole time is devoted to such pursuits, could bestow. Indeed, so

large a part of every country is covered with geest, and so imperceptible is the passage of some rocks into others, leaving the observer in doubt for miles which rock predominates, that after all, two equally good geologists would not probably fix the limits of different rocks precisely alike. And to exhibit all the minor salient and reentering angles which any rock makes on the surface, would require a map on a scale five times larger than that used in the present instance. In attempting, therefore, to give every rock that position and extent on the map which it actually occupies on the surface, I do not suppose I have done any thing more than to approximate to the truth. It is hoped, however, that the approximation is sufficiently close to answer most of the purposes of geology. I trust at least that this outline will furnish assistance to succeeding geologists.

In constructing this map I have derived very great assistance in the vicinity of New-Haven, from the researches of Professor Silliman, and of Dr. Percival. Indeed, could either of these gentlemen have been induced to form a map of that region, I should gladly have omitted the southern part. In the northern part of the map, I have been assisted by Dr. J. A. Allen, Lecturer on Chemistry in Middlebury College, and by Rev. J. Andrews, of Putney. Dr. E. Emmons, of Chester, has also communicated facts of importance.

The sides of the map are not precisely meridians; but incline 3 or 4 degrees to the right, as is evident from the *fleur de lis* attached to the upper right hand corner. The longitude and latitude are marked from those of Deerfield, which have been determined by numerous observations.

Having made these preliminary remarks, I now proceed to describe the several rocks occurring in this district, in the order in which they are put down in the explanation of the colours on the upper left hand corner of the map.

1. Granite.

Coloured purple—or a mixture of carmine, red, and Prussian blue.

Almost every variety of this rock described by geologists occurs in the region of the map, except the transition

granite of Norway and Scotland. Its texture varies from the coarsest to the finest grain, and it exists here in most of the forms that have been noticed.

East-Haven Granite.

The deposit of granite marked in East-Haven and Branford, has its southwestern extremity at the Lighthouse, which stands on a sea beaten rock of this description. The grain is intermediate between fine and coarse, and the felspar is usually reddish. In passing from East-Haven to Branford, we find the granite immediately succeeding the old red sand stone, or the slate rocks of the coal formation, or the greenstone; and all these rocks are nearly on the same level. Their actual contact with the granite, however, has not been observed, being hid by geest.

There is no evidence that this granite constitutes a bed in other rocks: On the contrary, it would seem, that it was brought to view along the coast by the abrasion of the gneiss and mica slate, which appear a few miles to the north, and which there lie at a much higher level. On passing east and northeast from this granite deposit, well marked beds of this rock appear; and perhaps all the granite which is found at the mouth of Connecticut river occurs in this form.

I do not know exactly how far the East-Haven granite may be traced along the coast. Certainly the gneiss reaches the sound before we come to Connecticut river.

In the cavities of this granite, where it is washed by the tide, one or two species of *Lepas* and other *testacea*, have fixed their abodes, finding security in those projecting crags which are so appalling and dangerous to the mariner. Some *Ulvae* and *Fuci*, also, are found along the shore.

South Hampton Granite.

Although the granite thus designated extends but a little distance into South Hampton; yet it contains the South Hampton lead mine, which will, no doubt, be long an increasingly interesting focus to which mineralogists will be

drawn—and therefore, the specific name above given, may not be unappropriate for this granite.

A great part of this granite exists in beds in mica slate; gneiss being a rare rock in the vicinity. Indeed, it may be doubted whether the whole range is not in the form of beds. I think, however, it will be found that there is a central ridge which is fundamental, at least two or three miles broad, extending from South Hampton through Williamsburg to the southwest part of Conway and northeast part of Goshen. Certainly, along this line little else appears but granite; and in some places, as at its northern extremity, this rock forms hills of considerable elevation, and extensive ledges. Beds of granite may indeed be found in the vallies between these ledges; but an observer as he passes over this region and proceeds south to South Hampton lead mine, will find it difficult to persuade himself that he is not traversing an original fundamental* deposit of this rock. Or if it exist in beds alternating with mica slate, it will in some instances be found no easy matter to prove it—the mere fact that mica slate is found on both sides of it not being sufficient evidence: the same being the case with an original deposit.

I would here suggest whether the mica slate of this region, that contains beds of granite, may not be a newer formation, reposing immediately upon that granite nucleus which probably forms the basis rock in New-England. And wherever this mica slate and upper granite is worn away, or there is a projection in the nucleus, the basis rock may appear. Such a supposition will account for all the appearances of the region we are now considering, which is coloured on the map as granite.

As we go east or west from what I have called the central ridge of this granite, the beds of this rock become more and more distinct, the mica slate, however, increasing in

* "The term fundamental, has, it should seem, been gratuitously predicated of a particular description of granite; for by the terms of the proposition, the bottom of this formation has never been seen, and consequently we have no means of determining whether it be fundamental or not."—*Ed. Rev. Jan.* 1820. p. 89.

But, we should ask, whether it be not proper to say of space, that it is infinite, for the very reason that we cannot limit it? And with equally good reason, it would seem, we may say of granite that it is fundamental, because we have never found any other rock below a particular description of it.

quantity and the granite decreasing. In painting what is denominated the South Hampton granite, I have comprehended most of the Chesterfield and Goshen granite,* which has become celebrated on account of the interesting minerals found in it—although the mica slate in those towns occupies probably as much of the surface as the granite. The purple colour, or that which represents the granite, has not been extended so far as to embrace all the beds of this rock in this region; but only so far as the granite predominates. Where the mica slate is most abundant, I have put down this rock as covering the whole surface, although it might contain many beds of granite.

The inclination of the mica slate strata, or dip below the horizon, and consequently of the granite beds, varies from 20° to 90°: and thus frequent opportunities are afforded for observing the former rock pass under and over the latter. The width of the beds varies from the fraction of an inch to 100 rods: nay, perhaps to a mile or two. So that in the narrow beds, a single glance of the eye will present their roof and floor. In these thin beds there is rarely any fissure; but in those several hundred yards in width, are frequently observed regular and irregular divisions, as will be more particularly noticed hereafter.

These distinctly characterized granite beds are not confined to the region of the South Hampton granite. A few miles north, indeed, they disappear; but they may be traced southerly into Litchfield county, where they exist abundantly, and are sometimes found in hornblende, slate, and gneiss. A good example of the former may be seen in Granville, about half way between the churches in the east and west parishes; where the layers of hornblende slate are nearly perpendicular. Instances of their existing in gneiss may be seen in abundance on the east side of Connecticut river, in Pelham, Monson, Chatham, Haddam, &c. Indeed, we think the geologist who traverses New-England primitive rocks will often be led to enquire, whether all our gran-

* "We have visited these localities more than once, and have no hesitation in saying that more distinct and well marked beds do not exist in this part of the United States or Europe; and what renders the fact more interesting is, the distinctly stratified structure of some of them."—*N. Amer. Rev. No.* 29—p. 233.

ite does not occur in the form of beds or veins. We are not yet, however, prepared to believe any one could conclude that it does. East-Haven granite, Black Mountain, a part of Leverett range, &c. stand as yet in the way of such a supposition. Still less are we ready to adopt the recent opinion of a distinguished European geologist,* that *granite is not a primitive rock*, and that the only two rocks that are so, are mica slate and gneiss!

Thus have we in New-England, as in the east of Ireland, granite of a decided character alternating with mica slate. But this ceases to excite any surprize, since Von Buch and and Jameson have given us an account of the strata of Christiana and Haddington.†

The texture of the South Hampton granite is generally rather coarse. There is, however, in this respect, a great variety. The felspar is usually of a fine white colour, and the quartz and mica a light gray. I do not here, however, speak of the granitic veins, some of which traverse the granite itself, and the felspar of which is sometimes flesh coloured. The beds of the South Hampton granite are not rich in minerals, except the lead mine in that town. The veins in this rock, however, contain the fine tourmalines and beryls of Chesterfield, and Goshen, and Haddam.

Black Mountain.

This lies in Dummerston, Vermont, and consists of granite. A geologist standing in Brattleborough on the argillite is surprized on looking northwesterly, and seeing only four or five miles distant, an abrupt mountain 500 or 600 feet

* Dr. Borré.

† Porphyry in immense mountains reposing upon lime stone full of petrifactions; a sienite over this porphyry, consisting almost entirely of coarse grannlar felspar, and in the same manner, a granite not different in its composition from the granite of the oldest mountains—granite *above* transition lime stone! Granite as a member of the transition formation!"—*Von Buch's Travels in Norway*, p. 45.

Order of the transition rocks around Christiana, beginning at the top and reckoning downwards.

1. Zircon sienite. 2. Granite. 3. Porphyry. 4. Sand stone. 5. Flinty slate. 6. Compact gray Wacke. 7. Compact slate and black orthoceratite limestone. 8. Granite. 9. Clay slate and limestone, probably. 10. Gneiss.—*Ibd.*

high, evincing by its white and naked head that it is gneiss or granite. On visiting it, he will find it to be a fine grained granite. In many parts, however, he will perceive such a tendency to stratification, that he may doubt for a moment whether it be not gneiss. But upon examination he will refer it to granite. The same remark will apply to granite in many other parts of New-England. It seems, and probably is, in many instances, intermediate between well characterized granite and gneiss.

Black Mountain is not many miles in circuit, and on the north and west, is succeeded by well characterized gneiss. This gneiss is quarried and forms underpinning and step stones; specimens of which may be seen in the foundation of the Meeting house in Brattleborough, East Village.

On Black Mountain I noticed some interesting lichens. The most monopolizing of these, are the *Gysophoras. G. vellea*, *papulose* and *muklenbergii;* (Acharius) in some instances actually cover precipices 30 or 40 feet high, and crowd one another notwithstanding, so as to force up their broad margins, giving them the appearance of a *chapeau de bras*. These species are found also on the granite in Montague, and on the greenstone in Deerfield, where occurs also g. *deusta*. On Black Mountain I likewise noticed in abundance *Enclocarpon miniatum Ach.* and several species of *Parmelia* and *Lecidea*. Near its top grows *Milium involutum (nov. sp. Torrey*, MSS.*)*

I cannot but detain the reader a moment to explain the strange nomenclature by which those were governed who originally gave to this granitic peak the name of *Black* Mountain. Every body in passing is struck with its snow *white* aspect, and cannot help enquiring the cause of it. I was told that in early days, it was burnt over and derived its specific appellation from this circumstance. Thus an accidental and ephemeral fact has fastened a name upon it which its constant appearance belies.

A similar remark might be made in regard to the name of another mountain in the same vicinity. A person standing in Brattleborough East Village, perceives directly *east* of him, on the *east* bank of Connecticut river, a venerable mountain 800 or 900 feet high, seeming almost to threaten him with its overhanging fragments. On enquiring the

name of it, he will be told it is *West* River Mountain. And on examination he will find that West River empties into the Connecticut from the west, nearly opposite this mountain.

Granite range passing from Amherst through Leverett, &c.

This granite is generally found at a low level. Almost every other rock in the southern part, excepting the alluvion, rises higher than this. Along the central and eastern parts of Amherst it is mostly covered by geest and alluvion. It appears, however, two miles south east of the Collegiate Institution, and I have no doubt that Seminary stands on this rock;* although some bowlders of pudding stone appear there. Two or three miles north of the College, it emerges in abundance, and becomes broader through Leverett, which is perhaps one of the best places for examining it; especially when we consider its proximity there to pudding stone. Mount Toby, which is 800 or 900 feet high, lies on the western border of the granite and consists principally of a peculiarly conglomerate rock which appears to belong to the coal formation. This pudding stone rises 400 or 500 feet higher than the granite, and in the intervening valley the two rocks approach very near each other; although I have never been able to find the actual junction. The granite, however, near the pudding stone, occurs in beds in mica slate, and is separated from the pudding stone, by this mica slate, or by hornblende slate, which appears in the valley above named, or by an imperfect variety of sienite. The mica slate in this place, and indeed along the whole western border of this range of granite, near the northwest corner of the town, becomes mere *quartzose slate*, having a slight glazing of mica, or mica in small scattered scales. This quartz is divided in two directions by seams oblique to the face of the layers, so as to separate the rock into very regular rhombs with different degrees of obliquity. In hand specimens, indeed, it seems to be limpid quartz in very perfect distinct concretions.

In the valley between these rocks appears to have been for ages a war of *avalanches* between the pudding stone and granite; in which

*It stands on sandstone

——————"hills amid the air encountered hills,
Hurl'd to and fro with jaculation dire,"

And evidently too to the advantage of the pudding stone: for this is several hundred feet the highest, is more steep and more easily broken up from its bed, so that its debris has evidently gained upon the older rocks, and subjected some of them to its dominion.

In this valley the lichens, mosses and fungi, have planted themselves thickly upon the bowlders and decaying logs where they are secured by the dense foliage of the trees from the too powerful rays of the sun and moistened by the vapour of a small brook which here finds a passage. You there see *Sticta pulmonacea (Ach.) and Jungermannia platyphylla*, fantastically fringing the rocks, while the ever verdant *Polypodium vulgare* frequently crowns the top. *Parmelia saxatilis, caperata*, and others, several *Lecanoræ* and *Lecideae, Peltidea canina, Poicna pertusa Ramalina fraxinea* and *Cenomyce coccifera* and *rangiferinæ* of *Acharius, Hedwigia filiformis, Bartramia crispa, Polytrichum perigoniale*, several species of *Hypnum, Dicranum, Orthotrichum*, and many other genera grow there. On the decaying trees along this valley, you not unfrequently may see the delicate *Boletus versicolor* and *betulinus*, the elegant *B. cinnabarinus* and *lucidus*, and the useful *B. varius, velutinus* and *igniarius, (Persoon.)* Here too may be found *Agaricus alneus (Pers.) Daædalea cinerea* and *Polyporus abietinus* of *Fries;* various *Thelephorae, Hydra, Clavariae, Peziza*, &c. And the margin of the brook has in many places a carpet of *Marchantia polymorpha* and *conica.* Near the northern extremity of this valley is a pond, in and around which are many rare and interesting phenogamous plants—such as *Drosera rotundifolia* and *longifolia, Nuphar advena* and *Kalmiana Nymphea odorata, Utricularia striata* (n. sp. Le Conte) *Myriophyllum verticillatum*, one or two *Charae, Cnicus lanceolatus, attissimus arvensis, discolor* and *muticus; Rhynchospora glomerata* and *alba Najas Canadensis* and *Scirpus subterminalis* (n. sp. Torrey MSS.) In the outlet to this pond grows the singular *Spongia fluviatilis* of Linnaeus.

But to return to the granite. Along the southern and central parts of Montague, it is greatly hid by the gneiss and mica slate. In the northern part of the town, however,

near the mouth of Miller's river, it appears in one or two detached eminences of considerable height; directly west of which, only a few rods, is another hill of puddingstone similar to that of Toby. The granite can be traced nearly all the way through Northfield at a low level, and in the north of this town it seems to pass under the geest and higher rocks, and to appear again in Winchester and Chesterfield, of greater width, and here it is beautifully porphyritic. As we go north, the rock exists in distinct beds in mica slate and gneiss, and also it appears at the tops of mountains sometimes forming conical hills almost naked. Witness the west part of Surrey and Alstead.

The texture of this granite is coarse, in some instances very coarse, the plates of mica being several inches across. Its usual colour is white. A beautiful variety, however, occurs in Leverett, in which the felspar, which is abundant, is of a light blue; the quartz of a dark blue, approaching to black; and the mica the usual light gray. This a rare variety, and a fragment of a crystal of this blue felspar measured in its longest direction 8 inches.

This range of granite contains several veins of metals, such as galena, copper pyrites, blende and iron; which will be more particularly described hereafter.

Much of this range exists in the form of beds and veins: yet so far as I have examined it, it will not be easy to prove that the whole of it can be referred to this form. I am yet of opinion that along the central parts of the range may be seen emerging an original fundamental deposit of granite.

These are all the depositories of granite of considerable extent, which I have discovered in the region embraced by the map. Granite exists in many other places along this river in beds and veins; but not of sufficient extent to claim to be represented on the map. It is possible, however, that what I call beds and veins, may not in all cases be such: For it is generally allowed, I believe, that the basis rock in all New-England is granite, and this nucleus, if I may so call it, is doubtless very uneven, having many prominences and corresponding hollows. In some places, perhaps, these projections have never been covered by other rocks, such for instance, as black Mountain. In other cases there is every appearance to indicate that the higher rocks have been worn away, and thus the granite has been disclosed:

for in general, the granite along the Connecticut appears much lower than the neighbouring rocks, such as gneiss and mica slate. No person who examines the East-Haven granite, or that running through the Leverett, or even the South Hampton deposit, will doubt that some powerful agent has swept away an immense mass of superincumbent rocks of some description or other. Whether this was a primeval northeasterly current as Mr. Hayden maintains, I shall not undertake to decide. Be it, however, what it may have been, wherever it has acted powerfully we may expect to find the granite laid bare. If these remarks are correct, we need not be surprised to find this rock any where, even if we cannot make it form any thing like continuous ranges, and perhaps some of those small masses of granite, which every one who has examined New-England knows, appear so frequently, and which being surrounded by gneiss or mica slate, we are apt to refer to beds or veins may, after all, be the top of a projection of the nucleus of the globe which the abrading agent has laid bare.

Bellows Falls Granite.

This is of quite limited extent; but the interesting nature of the spot where it occurs induced me to colour it and notice it thus particularly. Fall mountain on the east bank of the Connecticut at Bellows Falls, consists of a coarse, not very perfectly stratified mica slate. At its western foot in the bank of the river, the stratification becomes less distinct, and is at length, about the middle of the stream, entirely lost; and the rock becomes an imperfect granite. In other words, there is a graduation from the mica slate into the granite. In the western bank, in the village, the characters of the granite are more decided; though even here, I should have no hesitation in calling it a sienitic granite, did it contain any hornblende; but I could discover none. The mica is black and abundant, thus giving the rock a sienitic aspect; and it is also traced by veins of felspar and granite like the sienitic granite of Northampton and Belchertown, to be described hereafter. The ingredients of this rock are arranged when viewed on a small scale somewhat in distinct layers; but when regarded as a whole, I never

saw a rock farther from *stratification*. Sometimes the felspar is wholly wanting, and the rock appears to be mere *unstratified mica slate*, if such a term does not contain a contradiction. It is of no great extent, being evidently laid bare by the waters of the Connecticut, which here urge their way in foaming fury over its ragged cliffs. The same rock occurs two miles east of the falls; but, as far as I examined it, it seemed to occupy no great space.

Stratification of Granite.

Probably the granite of the Connecticut will leave the question* on this subject undecided. For some of it is evidently stratified and some of it is not. That which exists in not very extensive beds exhibits, so far as I have examined the subject, the most decided marks of stratification. It is not unfrequent to see the bed divided into layers parallel to its roof and floor, and from one foot to two feet thick. This is readily distinguished from gneiss by the much greater thickness of the layers and the want of a stratified arrangement of the ingredients. In other instances, more rare, however, we observe what Saussune would call vertical plates *(feuillets)*—that is, thick tables of granite perpendicular to the horizon, crossing the bed sometimes at right angles and sometimes obliquely. These plates are also found making a dip to the horizon—In all these cases, however, the plates being parallel, or nearly so, the rock would be properly denominated stratified. Examples of these various kinds of arrangement may be seen in Conway, Williamsburg, Goshen, and Chesterfield. Yet the greater part of our granite is divided by numerous fissures into these irregular blocks that bid defiance to precise description.

Granitic Veins.

By veins I understand those zones of any particular rocks, or mineral, which traverse another rock, either rectangularly or obliquely to the direction of its strata. In *crossing* the strata they differ from beds.

* See Greenough's First Principles of Geology.—Essay 1.

Granitic veins are very numerous in many parts of the map, especially in the region of the South Hampton granite. In width they vary from a mere line to 30, and perhaps even 40 feet. But I have not observed any that exceed this breadth. They traverse mica slate, hornblende slate, limestone of a peculiar character, sienite, gneiss and granite. Those which traverse the latter rock differ from it only in being of a finer, or a coarser grain. Yet they are as really veins as those zones of granite traversing other rocks. Examples of these are frequent—as near the South Hampton lead mine.

In these veins all the ingredients of granite are usually present, but in variable proportion. I have seen some that were nearly or quite graphic granite: But usually the mica is in superabundance, especially in the narrower ones, and often it is of a delicate straw or light green colour, as in Goshen and Conway. The felspar is sometimes of an elegant flesh colour, especially in those veins occurring in the gneiss northeast of New-Haven, in Chatham, Haddam, &c. These veins frequently divide and subdivide like the top of a tree, some of the branches being smaller and some larger. These branches rarely go off from the main stock at right angles, but generally oblique. At one place you will see a vein retaining its width for several feet, or even rods, with mathematical exactness—at another, its width will gradually increase or decrease; and I have seen, in some instances, a sudden reduction of two or three inches, by which a shoulder was produced. The course of many of these veins is serpentine, resembling that of a river on a map—yet often they scarcely deviate at all from the right line. Sometimes they make large curves to the right or left. They usually descend into the rock obliquely to the horizon. They frequently intersect, but I have never noticed any displacement of the strata, or mass of the rock, except in the sienite. Some of the veins traversing sienite, (between Belchertown and Ludlow for example,) are so numerous and their intersections so many, that they form what the Germans call a *stock worke*, except that they are not metalic. By these cross veins the surface of the rock is sometimes divided into triangles, rhombs, or rhomboids; and sometimes it is tesselated.

The veins traversing sienite are most frequently granite, the felspar being of a flesh colour. They are more numerous in this than in any other rock, and are often intersected by one another and by thin veins of epidote. The crossing of these veins has produced many very interesting and singular displacements of portions of the rock. Where one vein is cut off by the intersection of one that is newer, it is not unfrequent to observe a lateral removal of the former with the whole mass of the rock surrounding it, from one to six inches. The vein itself, which is thus removed, is rarely altered or injured.

One of the most complete and curious cases of this kind is exhibited in Fig. 6. It was sketched by the eye without accurate admeasurement. A. B. C. is a triangular mass of sienite; the sides of which are 6, 4, and 10 feet. A. B. is a fissure in the rock: B. C. a vein of epidote and A C. the line marking the lowest limit of the rock above the soil. The whole rock is unbroken and as firmly united as any rock of this character ever is. There appear originally to have been two veins of granite traversing the rock in its longest direction, the smallest an inch wide at one end and widening towards the other, and the longest 2 or 2 1-2 wide. These have been cut through and strangely displaced by numerous veins of epidote crossing obliquely.

a, *a*, *a*, and *b*, *b*, *b*, &c. represent the granite veins as displaced.

d, *d*, *d*, &c. represent the veins of epidote which are rarely more than one quarter of an inch thick, and a few of which are represented on the plate.

c is a mass of gneiss or mica slate imbedded in the sienite and crossed by the granite vein *b*.

The locality of this rock will be described when we come to speak of sienite.

In those rocks that are stratified these veins make every possible angle with the direction of the strata. And if I do not mistake, the nearer they approach to the same direction as the strata, the broader they become, and have a nearer resemblance to beds. Sometimes they approach so near the same course as the layers of the rock they traverse, that it requires nice examination to determine whether they deviate at all. A good example of this occurs in a locality which many geologists have visited, and which many more

will probably visit. I refer to the main body of that enormous vein containing the green tourmalin, rubelite, &c. in Chesterfield. We think it might even admit of a question whether this be a bed or a vein.

The veins of which we are now speaking are doubtless contemporaneous ones—that is, such as were consolidated at the same time with the rocks they traverse. There is no seam or layer of another rock at their sides, but they are usually so firmly united to the rock which contains them, that they are separated from these with as much difficulty as they are broken in any other direction. I have, however, frequently noticed a seam traversing the middle of the vein—so that if the rock they traverse be broken up, one half will cleave to one side and one half to the other.

A real *lusus naturae* exhibiting the fine cohesion of these veins to the rocks they traverse, now lies before me. A slab of granite being a vein $2\frac{1}{2}$ inches thick, 10 inches broad, and 20 inches long, curved a little upwards at one end, forms the base of the specimen. From the centre of this, rises perpendicularly a bladed, taper-pointed column of a peculiar limestone, only 2 inches thick, 10 inches broad at the base, and 26 inches high, appearing as if mortised into the granite. The contrast between the light coloured granite and the dark gray limestone, is very striking. The secret of its having been brought into this singular form appears to be this. It was found in a mountain torrent in Conway, and the granite doubtless once formed a vein in the limestone. On one side the limestone has been entirely worn away by the water—and on the other side, it is worn so as to leave only the bladed column above described, which still adheres firmly to the granite.

I have said that these granitic veins are contemporaneous ones: And it would seem that the judgment of no man could be so warped by theory, as to believe, after examining them, that they were once fissures made in the rocks they traverse, *after these were consolidated*, and that these fissures were filled by a solution of water above, or by a fiery furnace beneath. There is just as much reason for believing that one of the constituents of granite, quartz for instance, was introduced into the rock in this manner after the other constituents were consolidated; or that the imbed-

ded crystals of porphyry are not of the same age with the base.

Granitic veins are numerous in many parts of the map. Commence at Conway and go south, and they will be found in abundance nearly to the ocean. North of this town I have never noticed any. On the east side of Connecticut river, also, they are not unfrequent, particularly in Connecticut. Many of the interesting minerals of Haddam and Chesterfield occur in them.

Veins of quartz are sometimes seen in this region traversing granite, as in Conway. But they are not extensive, or numerous. I have noticed also that sometimes the granite contains, imbedded in it, masses of mica slate having a curved form and not rounded; as on the top of the high hill between Williamsburg and Chesterfield.

Graphic Granite.

This is a rock not uncommon in the region of the map. I shall notice two of the finest localities. The first is in the red conglomerate, or coarse sand stone, passing through Deerfield. The imbedded masses in this rock are sometimes the most beautiful graphic granite. The felspar, although it retains its lustre most perfectly, appears to be thoroughly penetrated by the colouring matter of the conglomerate so as to become of a deep flesh colour. The quartz is gray and limpid, or a little smoky, and being arranged somewhat graphically, many of the specimen are truly elegant.

The other locality of this rock, is the Goshen granite, in the northeast corner of the town. The felspar is of a snow white, and the quartz limpid; and so perfectly graphic is its arrangement, that it bears a close resemblance to the Chinese or Hindostanee characters which are frequently observed on goods from the East-Indies.

Porphyritic Granite.

This handsome rock occurs in great abundance in loose rolled pieces along the range of granite passing through Leverett, &c. The crystals of felspar are from one to two inches long, and a half or three quarters broad, and some-

times the face presented is a square. Thus an idea is conveyed to the observer, at first, that the crystals are rectangular parallelopipeds and cubes; although it is well known that felspar never crystallizes in either of these forms. The felspar of these imbedded crystals, when broken, exhibits the pearly lustre of the folia very well The granite containing these crystals is almost uniformly of a coarse texture.

This porphyritic granite is carefully to be distinguished from glandulous gneiss, which also occurs abundantly along the Connecticut. Let any one pass from Hinsdale, New-Hampshire to Winchester and he will see numerous bowlders, often ten feet diameter, of a rock having the granite constituents and exhibiting no appearance of a schistose structure. In one place at least he will cross the rock in place; and he will have no doubt that it is the most decided granite. And yet it is elegantly porphyritic. This rock occurs also in Chester where Dr. Emmons has traced a range of it five or six miles. Numerous bowlders of this rock are scattered over the town of Woodbridge near New-Haven: but I do not know from whence they originated.

Pseudomorphous Granite.

I put this adjective to a variety of granite that occurs along the Connecticut, not to show my dexterity at coining new terms, put to make myself understood. I am inclined, however, to think that the rock to which I refer is not exactly described in the geological books which I have seen, unless it be by Cleaveland, when he says, "some varieties (of granite) are divisible into imperfectly columnar or tabular concretions." (Mineralogy, vol. 2, p. 732.) It is a coarse grained granite with light coloured quartz and feldspar, arranged in the usual manner. The peculiarity lies in the mica. This is usually dark coloured, and arranged in plates from one to three inches across. The manner in which these are disposed, may be thus explained. Suppose the quartz and felspar to have been cemented together so as to form a perfect graphic granite. Next suppose the mass to be cut in various directions by a fine saw; and in the spaces thus made, imagine thin plates of mica, not more than $\frac{1}{50}$ of an inch thick, to be fitted. It is obvious that the

mass will thus be cut up into segments of pseudomorphous crystals. And so it is in the natural specimens: and it seems as though the hand of nature had really made use of a saw in their construction. The plates of mica meet at various angles, yet never cross each other; and the smallest piece of quartz or felspar is sometimes bisected, so that a part appears on one side of the plate of mica and a part on the other. This rock occurs in the S. Hampton granite; and may frequently be found in other parts of the region extending fifty miles south from Conway. At a little distance the dark bronze coloured mica appears like prisms of some imbedded mineral: and the travelling geologist is often tempted from his carriage in the almost certain expectation of obtaining from this rock shorl or titanium.

2. Gneiss.

Coloured Orange.

Although this is the most abundant rock in New-England, yet the map includes no very extensive portion of it. It stretches over a broad region without the limits of the map on the east and west, especially on the east. On the west it forms a part of the Hoosack or Green Mountains; though a much less part than has been usually supposed. On the east it appears with some interruptions of granite, mica slate, &c. within twenty or thirty miles of the coast, and on the north it spreads over a considerable part of New-Hampshire. The White hills are said to consist chiefly of this rock: though they have not, I believe, been thoroughly explored.

The dip of the layers of gneiss in this region varies from 20° to 90°—and it dips, like most other stratified rocks along the Connecticut, to the east. When it approaches to hornblende slate the dip is generally greater than when pure. This rock often contains crystals of hornblende; in every proportion, indeed, until the characters of gneiss are lost in hornblende slate. Especially is this the case on the east side of Connecticut river. More, however, will be said on this subject when we come to describe hornblende slate. Good examples of this gneiss containing detached crystals and even veins of black hornblende may be seen in the basement of the new Collegiate Institution in Amherst. It fur-

nishes an admirable stone for such purposes; and many quarries are opened in it. Immense tables of it may be procured, and should the mania for constructing pyramids ever seize the inhabitants of New-England, this gneiss might produce masses of stone rivaling in magnitude the immense limestone blocks of the pyramids of Egypt.

The gneiss of the Connecticut, often alternates with mica slate, and passes into it. In Granville, may be seen gneiss, hornblende slate and mica slate, in various stages of approach to each other, and making various alternations.

This mixture of gneiss with other rocks, and the consequent indistinctness of character, render it, in some instances, not very easy to give its limits. I have felt this difficulty especially in regard to the northern part of that gneiss range which occupies the eastern part of Litchfield County and appears so decided in its characters in Bristol, Plymouth, and Canton. In the west part of Granville, I feel confident gneiss is the prevailing rock—although mica slate alternates with it. Yet between Chester and Westfield there is nothing but mica slate, as the prevailing rock, which extends twelve or fourteen miles west of Chester, before we come to gneiss. And north of this we find very little gneiss within the limits of the map except a narrow stratum as we ascend the hill from Cummington to Goshen. I do not, therefore, feel exactly satisfied with the northern termination of the Litchfield gneiss as given on the map: but at present it is not in my power to re-examine it.

I would here, however, suggest that I have been rather inclined to believe that some of the stratified rocks along the Connecticut pass gradually into other rocks *laterally*, that is, *in the direction of the strata:*—mica slate, for instance, into gneiss, or hornblende slate; and argillite into mica slate. To establish this fact, however, requires a long series of very close and accurate observation. I merely suggest it, therefore, and do not assert it.

In some instances, the ingredients of our gneiss are pretty equally mixed: in others they are arranged in somewhat distinct layers, which are generally straight. It is not a rock that is rich in minerals with us. Veins of granite traversing it, however, sometimes contain interesting specimens. Witness the Haddam minerals.

Glandulous Gneiss.

This is very abundant, especially in the gneiss east of Connecticut river. Indeed, a considerable proportion of that range is occasionally glandulous, presenting numerous oval masses, chiefly of felspar. The layers of this variety of gneiss are usually very distinct, and it contains a large proportion of mica, which is usually of a blackish colour; and thus it is easily distinguished from the porphyritic granite above described.

3. Hornblende Slate, Cleaveland.

Coloured Vermillion, Red, and clouded with India Ink.

This is an anomalous and perplexing rock. It is not generally well characterised in this region: but I have put it down, because a rock approaching nearer the characters of this than of any other, occurs in considerable abundance along the Connecticut. I have no confidence however that I have given in all cases its exact situation or extent. Yet I believe that wherever this stratum is coloured on the map, the rocks may be found in the vicinity. Thus in the range extending from Belchertown to Guilford, Ct. a person will generally find this rock more or less abundant in crossing from the secondary rocks to the gneiss: but sometimes he may thus cross and miss of it, unless he make an excursion to the right or left; and sometimes he must cross a portion of the gneiss before he reaches it. The continuity of the strata of this rock seems to be much less perfect than in the gneiss or mica slate, and the direction of the strata is often oblique to that of other rocks:—a remarkable instance of which occurs in the south east corner of Halifax, Vt. The dip of the strata varies from 45° to 90°, and the schistose structure in the purest specimens is very perfect, the layers varying in thickness from half an inch to three inches.

But there is another difficulty in ascertaining the limits of this rock. It is no easy matter to draw the line between it and gneiss, all, or at least, two of the ingredients of the latter rocks being sometimes present, while more than half of the rock is hornblende. Indeed, I have sometimes been dis-

posed to regard this rock as gneiss containing an accidental proportion of hornblende; and this would have been a satisfactory description of a considerable part of the rock which I have called hornblende slate. But another part appears to be decidedly that species of Werner's primitive trap described under the name of hornblende slate in Rees Cyclopedia, *Article Trap*—that is, it consists of hornblende, generally fibrous and crystalline, having a very distinctly slaty structure. For localities of this well characterized hornblende slate I would mention the eastern part of Halifax, Vermont, also New Fane and Belchertown, two miles north of the meeting house on the west side of the road, and in the western part of Tolland and Monson.

I think however that the largest part of this rock will be found to consist of hornblende, quartz and mica—the latter being usually black and very apt to be confounded with the hornblende, so that perhaps it deserves the name of a granitic aggregate. In some instances, also, this rock contains chlorite, and verges towards greenstone slate. It is often strangely intermixed, and alternates with gneiss and mica slate.

Another portion of this rock has a porphyritic aspect. I use the term porphyritic in this place, not in the usual sense, as denoting a compact ground with imbedded crystals, but as a "granite ground, in which some crystals are much larger than the rest." (*Bakewell's Geology*, p. 28.) The slaty structure of the rock, though less distinct, is not lost: but the imbedded fragments, or imperfect crystals of quartz or felspar, most frequently the former, give it a porphyritic appearance. These imbedded fragments are frequently granular, while the base is distinctly crystallized. A good example of this variety of rocks occurs in the west part of Chatham and in Shelburne. Sometimes this rock becomes the real sienitic porphyry of authors—its slaty structure being lost. This occurs in Plainfield, in Hawley, a few rods west of the meeting-house, and at the falls in Deerfield river in Shelburne.

These porphyritic rocks, however, must be quite different from any thing occurring in Europe by this name, if a remark of Brongniart be correct, that "we are not at present able to find a sienite or porphyry which is evidently primitive." For we have as much evidence of the primitive char-

acter of the rocks above described, as of the mica slate and gneiss with which they are associated and in which they sometimes form beds.

Hornblende slate occurs on the west side of Connecticut river, south of Shelburne, in Massachusetts and Connecticut, also at Plainfield and Hawley. But it is not abundant or well characterized generally, and is much mixed with, and passes into other rocks; and therefore I have coloured it only in the range from Belchertown to Guilford and from Shelburne northward. Good examples of the rock containing quartz and some mica may be seen in the flagging stone of the side walks along the eastern side of the Public Square in New-Haven, and in other parts of that city.

4. Mica Slate.

Coloured Green.

This is an extensive stratum in the northern part of the map. On the west side of the river it forms the prevailing rock; and its width continues to increase northerly, so that it occupies the principal part of Vermont. Prof. Silliman in his "Tour between Hartford and Quebec," says that he crossed this state obliquely from Burlington to Hanover, a distance of 84 miles, and found mica slate by far the most abundant rock on the route. (*Tour*, &c. p. 386.) In Connecticut, however, along the river, this rock constitutes no very broad ranges. Those which are coloured immediately in contact with the secondary on both sides of the Connecticut are in most places quite narrow, often not more than half a mile, or even but a few rods wide, and sometimes they wholly disappear and we pass from the sandstone immediately to the hornblende slate or gneiss.

The dip of our mica slate is variable from 20° to 90°. In Vermont it is usually less than in Massachusetts; especially where we first strike it in passing from the river. Farther south, as in Hawley, Plainfield, Chesterfield, &c. it approaches 90°. East of Chesterfield the layers of this rock lean to the west. Beyond Chesterfield, on the west, they lean the contrary way—that is, to the east. The same is the case between Chester and Westfield. This fact looks like an indication of a fundamental ridge of granite, extending in

that direction, as we have already suggested; although it may not yet have made its appearance above the later rocks the whole distance.

This rock is somewhat Protean in its appearance; yet not very difficult in most cases to be distinguished by careful observation. The following varieties have been noticed in this region. 1. A variety already referred to, as occurring in Leverett, near the pudding-stone; which is scarcely any thing more than imperfectly limpid quartz, divided into distinct rhombic concretions, about an inch thick, and three or four across the outside, slightly spangled or glazed with mica. 2. Very much like the last, except that it does not divide into complete rhombs, but is only separated by seams oblique to the direction of the strata, and nearly perpendicular to the horizon*—Locality, West-River mountain in Chesterfield New-Hampshire. 3. Divided as the last by two sets of parallel planes, forming angles with each other a little oblique: But the mica is intimately disseminated in fine scales through every part of the rock, and the quartz becomes a mere siliceous sand, blended closely with the mica. Surface rarely waving—Locality, Whately, Conway, &c. 4. Not regularly divided in any direction, except that of the strata, and much less fissile than the last. Mica scattered in fine scales through the mass, and the silex more abundant than the last—Rock breaking into huge blocks, from one to three feet thick, and often forming, like greenstone, abundance of debris. Locality, West-River mountain and Deerfield. These four varieties occur on the borders of the secondary rocks. 5. Tortuous, wavy and extremely irregular, embracing numerous beds and amorphous masses of quartz—Mica, very imperfectly characterised, forming a kind of glazing with the aspect of plumbago. Locality, Conway, Shelburne, Colrain, &c. 6. Quartz and mica in somewhat distinct layers—quartz predominating, and mica not very well characterised—abounding in garnets —Locality, Plainfield, Hawley, Conway, &c. 7. Passing into talcose slate—mica abundant, having somewhat of a fibrous aspect and connected with talc. Northfield and Hawley. 8. Passing into argillite. Locality, Leyden, Ches-

*"When one set of parallel planes crosses another, are both sets to be called strata, or neither, or only one of them?"—*Greenough's Geology, Essay* 1.

terfield, (N. H.) Putney, &c. 9. Not very fissile—breaking into thick blocks. Mica, abundant but poorly characterised—having somewhat the aspect of argillite—surface slightly irregular, appears as if grooved—Abundant in Cummington, Chesterfield, (Mass.) Vernon, Bolton, &c. 10. Quartz granular, abundant and white—resembling gneiss or granite—scarcely stratified at all—Locality, Buckland, Granville, &c. 11. Mica in distinct and abundant plates—layers very little tortuous or uneven. This usually lies next to granite. 12. Passing into gneiss—often rendered porphyritic by crystals of feldspar. Locality, Litchfield county.

The quartz that occurs in this mica slate, especially in the wavy and tortuous varieties, is commonly the white limpid: frequently it is the fetid, and sometimes a rich variety of a delicate red color. The coloring matter, however, is apparently iron, and therefore it is not the rose-red quartz. This variety of quartz occurs on the west side of the Connecticut.

It has already been remarked, under granite, that numerous beds of this rock are contained in mica slate. Indeed, our mica slate more frequently rests immediately upon granite, without the intervention of any other rock, than does gneiss. It also alternates with gneiss, hornblende slate, argillite and chlorite slate. Small patches of it, indeed, occur in very many places throughout the whole extent of the primitive along the Connecticut.

It is a common remark in geological books, that hills composed of mica slate are usually less steep and more rounded than those of granite. But the reverse is the fact in most cases along this river. The granite hills are generally low and rounded, while some of the most Tarpeian precipices to be found in this region are composed of mica slate. Take for examples West River Mountain, and the high hills of Heath, Hawley, Chesterfield, &c.

Mica slate is not wanting in a variety of minerals in this section of the country—such, for instance, as staurotide and garnets in immense quantities in Goshen, Chesterfield, Mass. and from Bolton, Conn. one huudred miles north, to Chesterfield, New-Hampshire Also the fine Chesterfield sappare. Also the red oxid of titanium, found almost every where between Conway and Brattleborough, a distance of thirty miles—and the Leyden tremolite—the Putney

green fluor spar, and the Wardsborough zoisite. The Chatham Cobalt mine occurs in mica slate.

The cryptogamous plants that usually overspread a great part of the mica slate of this region, though perplexing to the mere geologist, are yet interesting to the botanist. Among those which adhere to these rocks, or to the little soil that collects in their cavities, may be named, *Bartramia gracilis, Smith, B. longiseta, Mx? B. crispa, Swartz, Hedwigia filiformis, P. Beauv.* in great abundance; *Arrhenopterum heterosticum, Hedw. Buxbaumia aphylla, Lin. Fissidens adianthoides, Bryum roscum, Diphyscium foliosum, Spreng. Polytrichum perigoniale, Mx. Jungermannia complanata, L. J. platyphylla L. Cenomyce phyllaphora, and pyxidata, Ach. Stereocaulon paschale, Parmelia herbacea, saxatilis and caperata, Porina papillosa, and pertusa, Peltidea aphthosa and scutata, and Sticta pulmonacea,* all of Acharius. In the region of the mica slate, especially in Brattleborough and Conway, we frequently find *Bryum cuspidatum, Brid. Hypnum minutulum, Mx. H. flexile, Brid. H. serpens, L. H. cupressiforme, Hedw. Jungermannia nodifolia, Torrey, Maschalocarpus trichonitrion, Hed. Pterigonium subcapillatum, Brid. Neckera minor, Brid. N. pennata, Hed. N. viticulosa, Hed. Cenomyce coccifera, rangiferina, botrys, &c.—Parmelia colpodes, ulothrix, cyclocelis, parietina, plumbea, &c.—Lecanora tuberculata, subfusca, brunnea, albella, &c.—Lecidea parascena, cameola, demissa, &c.—Usnea florida and plicata, Cornicularia fibrillosa, Collema tunaeformis,* and *Alectoria jubata,* all of *Ach. Nephroma resupinata, Spreng. Glonium stellare, Muhl. Polyporus abietinus and squamosus, Fries. Hydnum quercinum and cyathiforme, Fries. H. imbricatum, occanum, coralloides and gelatinosum, Pers. Thelephora quercina and terrestris, Cyathus olla and striata, Stemonitis fasciculata, Boletus citrinus, badius, brumalis, nigro-marginatus, cinnabarinus, velutinus, betulinus, &c.* all of Persoon, and many scores besides of *Agaricus, Amanita, Sphaeria, Peziza, Daedalea, Helvella, Lycoperdon, Bovista, Scleroderma, Tremella, &c.* too numerous to mention in this place.

Scattered among the mica slate rocks we frequently find the *Helix alloläbris, Say,* or common snail; and also, in some situations, *H. alternata, Say.* In a pond in Ashfield is found *Planorbis bicarinatus, Say,* and *Cyclas similis, Say.*

In springs occurs a species of *Lymnaca, Say*, and in our larger streams, *Planorbis trivolvis* and *Unio purpureus, Say*, or common river clam.

5. Talcose Slate. *Rees Cyc. Bakewell.*

Talcose Schist. Maccullock.

Talcose Slate. Eaton.

Colored Gamboge yellow, and dotted with India Ink.

Bakewell defines this rock to be "slate containing talc," (Geology, p. 491,) and Eaton calls it "that kind of mica slate which is distinguished from mica slate by a kind of talc glazing." In this term I do not include soapstone.

There is but one stratum of this rock in the region of the map, of sufficient extent to render it necessary to delineate it. I have sometimes noticed on the east side of Connecticut river a kind of talco-micaceous slate: but not in abundance, and rarely in place. I have crossed the stratum which is colored on the map in Whitingham, Vt. where it is not less than a mile and a half in width. I have traversed it also in Hawley and Plainfield, and Professor Eaton says it extends into Worthington—so that on his authority I have extended it thither. The rock is of a much lighter color than mica slate. At a distance, indeed, it has the aspect of gneiss. The talc is nearly white, though sometimes of a light green, and it contains a large proportion of silex. The strata are but little undulating and nearly perpendicular, leaning a few degrees to the west. On its east side, where it passes into mica slate, an intermediate talco-micaceous rock is found, containing numerous distinct crystals of black hornblende, thrown in promiscuously, and exhibiting the most elegant specimens. One variety has a ground that is green; another has a white ground, and the contrast between these and the imbedded crystals is striking. Large slabs of this rock may easily be obtained; and if it will admit of a polish, it would certainly be a beautiful addition to those marbles and porphyries that are wrought for ornamental purposes. The varieties of this rock may be seen in any direction a few rods from the meeting house in Hawley; as likewise many

other singular and curious aggregates which I have never seen at any other place. Among these is sienitic porphyry—and sometimes the talco-micaceous rock has its surface covered with delicate fascicular groups of hornblende.

The micaceous iron ore occurs in the talcose slate, and I have never seen any of this sort of ore in any cabinet that will compare at all for beauty with that in Hawley.

6. Chlorite Slate. *Cleaveland.*

Uncolored, but dotted with black.

In the region under description, I know of but two deposits of this rock of sufficient extent to be marked on the map; viz. at West-Haven and Milford* and in Whitingham, Vt. At the former place it is but imperfectly characterised, especially at its Northern extremity. As we approach the coast, in West-Haven, its characters become more decided, and here we find numerous small crystals of octahedral magnetic iron ore disseminated through it. Where the cliffs of this slate have long been buffeted by the waves of the ocean, these crystals have been worn out, and are deposited in large quantities, in the form of iron sand, on the beach. On the east side of ~~West~~ New-Haven harbour, at the Light House, also, this sand appears in equal abundance—and tons of it may easily be collected. On that side of the harbour there is no chlorite slate; and whether the iron sand found there is the remnant of former chloritic strata now wholly disintegrated, or whether it is washed up from the bottom of the Sound, where these rocks doubtless exist, remains problematical. The latter supposition, however, seems most probable.

The chlorite slate of West-Haven is extremely tortuous and undulating, and is traversed by numerous irregular seams of white quartz. It alternates with greenstone slate and passes into it; and also with mica slate. These three rocks are often so blended together that the distinctive characters of each are lost. And as we approach the strata of the Verd Antique, they seem to embrace also some of the prop-

*West-Haven and a part of Milford have recently been incorporated into a separate town by the name of ~~Oxford~~ Orange

erties of this, and often to pass into it. Hence it is no easy matter, in many instances, to give a name to the Milford slate rocks, and the alternations above named, and also with unstratified primitive greenstone, are numerous—so that it was not possible in coloring the map to give to each of these rocks the precise situation which they occupy on the surface.

The direction of the chlorite slate strata, of which we have been speaking, is from north-east to south-west. They dip to the south-east, and their angle of depression below the horizon rarely exceeds 30°. Sometimes, however, it is 90°. I think it will be found that the rocks of Woodbridge and Milford pass laterally into one another. Thus, the chlorite slate at its northern extremity is usually somewhat talcose in its appearance, approaching to argillite, and as you pass south, its characters continue to be more and more developed.*

The chlorite slate colored in Whitingham, is the best characterised I have ever seen in New-England. It seems to be nearly pure chlorite, yet distinctly stratified, the layers being nearly perpendicular, leaning, however, a few degrees to the west. I know but little concerning the extent of this stratum. Where I have crossed it, it was less than half a mile in width. I have given it a place principally to excite an attention to it.

This rock also occurs in beds in argillite in Guilford, Vt. but they are not extensive.

7. Sienite. *Cleveland.*

Colored Gamboge Yellow, and crossed by oblique parallel black lines.

This rock is marked in three places on the map. The first is in Whateley and of very small extent—the second extends from Whately to the south part of Northampton; and the third is in Belchertown and Ludlow. The rock in the two last places is very much alike, being for the most part a kind of sienitic granite. In the first mentioned locality the rock is considerably different from that in the oth-

*I am indebted to Prof. Silliman for this suggestion.

ers. I shall confine my remarks principally to that range extending from Whately to Northampton, because I have examined this most.

As above remarked, this range appears to be mostly a sienitic granite, that is, a modification of granite; and very different from that sienite which is associated with graywacke and greenstone. A person coming from the west or north-west towards the village of Northampton, will pass over the most decided granite, associated with mica slate, till he comes within four or five miles of that place. He will then find the texture of the rock to be finer, and in some instances it contains a portion of hornblende, while the proportion of quartz is somewhat diminished, the felspar frequently becomes red. Veins of graphic and common granite, epidote, &c. are more numerous, and the rock appears more disintegrated than the coarse grained granite. In one part of a mass of this rock, may frequently be observed a considerable proportion of hornblende, thus giving the rock a sienitic aspect, while in another part, only a few feet distant, this mineral is wholly wanting. Coming nearer Northampton, however, we find the hornblende more and more abundant, until we arrive at the eastern edge of the range, where we find a rock containing little else than felspar and hornblende, forming a real sienite. I have never yet seen a specimen, however, in which careful inspection could not discover both mica and quartz. The felspar is usually deep flesh colored, and the hornblende sometimes black and sometimes green. On the eastern border of this range, especially about two miles north of the village of Northampton, on the west side of the stage road, this sienite assumes a trappose and somewhat columnar form, both among the loose masses and those in place.* Among the *debris*, the three sided pyramidal form is most frequent; sometimes we find a three sided prism, and sometimes, both among the loose masses and those in place, two, three or four faces of a prism of a greater number of sides.

Another spot for observing some interesting facts in regard to this rock, is the south part of Whately. Two miles south of the congregational meeting-house, on the road to

*This fact was first mentioned to me by that indefatigable and able naturalist, Mr. Thomas Nuttall.

Hatfield, is a manufactory of common earthen ware, and here a small stream, running east, has cut across the greater part of the sienite range, and laid the rock bare nearly the whole distance, which does not much exceed half a mile. Let a person follow up the south side of this stream, and in some of the ledges he will perceive a distinct stratification of the sienite, though of little extent; one part of the same ledge being often stratified and the other amorphous. In this place he will see, also, numerous intersections of granitic and other veins by which a part of the rock has been displaced. In one of the ledges a little distance from this stream, on the south side of a pond, may be seen the prototype of Fig. 6.

Another interesting fact may be noticed in the sienitic granite along this stream, especially on the northern side, near the earthen ware manufactory. *The rock here contains numerous imbedded masses of other primitive rocks, as gneiss, mica slate, quartz, hornblende, and a finer kind of sienite.* And what is peculiar, is that these imbedded fragments are almost uniformly *rounded*—as much so as those contained in the conglomerated rocks along the Connecticut; and they are often so numerous that the rock appears like a real secondary conglomerate. The masses are very firmly fixed in the base, and often there appears a mutual impregnation and sometimes the veins of granite cut through the imbedded fragments, as in Fig. 6.

Thus we have a real conglomerated sienite, and I had almost said a conglomerated granite : for much of the rock containing these fragments is destitute of hornblende, while all the ingredients of granite are present. And the instances in which this conglomerated rock occurs, are not confined to the particular locality above named—but it is to be found in many other parts of the range. I have seen bowlders of it in Surry, Alstead and Walpole in New-Hampshire, but I did not there see the rock in place.

The Northampton sienitic range lies at a very low level. A considerable part of it is hidden by a deposit of sand through which it sometimes projects. The sienite in Belchertown is also rather low. All the remarks above made, in relation to the Northampton range, except that in regard to its conglomerated character, will apply to this. The best route which I have found for viewing this sienite, after cross-

ing it in several places, is to pass by the right hand road from Belchertown congregational meeting-house, to the meeting-house in Ludlow.

The narrow deposite of sienite which is first mentioned above, as occurring in Whately, is somewhat different in its characters. Let the observer proceed northerly on the main road from the congregational meeting house one mile, till he comes to the farm of a Mr. Crafts. On the left hand side of the road he will find a ledge of rocks which are greenstone slate, nearly allied to hornblende slate, and sometimes to chlorite slate. Let him cross these strata westerly, about fifty rods, and he will come to a deposit of decided unstratified primitive greenstone, about twenty rods wide. Immediately succeeding this rock, he will find the sienite above named. It consists of nearly equal proportions of felspar and hornblende, the latter of a dark green and of a distinctly crystalline structure; and the former white and compact or very finely granular, entirely destitute of a foliated structure, or pearly lustre. These ingredients seem to be promiscuously blended, and the rock appears to be peculiarly well adapted for being wrought and polished for useful and ornamental purposes. The bed is not very extensive, only about six rods wide at the place above mentioned, and I have never been able to trace it more than one or two miles. It is separated from the mica slate by a narrow stratum of greenstone slate.

Sienite, or sienitic granite, occurs in many other places along the Connecticut; but in no other place have I found it extensive enough to deserve a place on the map, except perhaps in Chatham, and with the relative situation of this I am not sufficiently well acquainted. Where I have crossed it, it appeared to form a bed in porphyritic hornblende slate.

8. Primitive Greenstone.—*Cleaveland.*

Colored Carmine or Rose Red, and marked by parallel lines crossing each other.

This is one of Werner's varieties of primitive trap. If it be asked what that is, I should suppose Mr. Maclure's supposition to be not an improbable one, that "what Werner calls primitive trap may perhaps be compact hornblende; or per-

haps the newest floetz trap when it happens to cover the primitive." (Journal of Sci. Vol. 1. p. 212.) Yet there are two circumstances in regard to the rock here denominated primitive greenstone, along the Connecticut, which have led me to doubt its exact indentity with our newest floetz trap, or secondary greenstone. 1. The primitive greenstone is never amygdaloidal; while a great part of the secondary is so. 2. The primitive greenstone not merely covers other rocks, but forms beds in them. An example of this may be seen one mile east of the Milford marble quarry on what is called the old road leading to New-Haven; where the greenstone lies between strata of a rock intermediate between greenstone slate and mica slate, and the rocks have every appearance of being contemporaneous.

Primitive greenstone is colored in the following places on the map, viz. at West-Haven and Milford—at Wolcott—at Whately, in the western part of Northfield and north part of Gill. In regard to that in Wolcott, or the Eastern part of Waterbury, I know but little, it being several years since I observed it, and some snow being on the ground at the time. I put it down merely for the sake of pointing out its locality.

The most extensive deposit of the rock is at West Haven and Milford; on both sides, but especially on the east side, of the Verd Antique stratum. The hummocks of it that appear very frequently, but irregularly, very much resemble the detached hills of secondary greenstone, except that they are less elevated and the blocks of debris are usually larger. A little south of the Derby turnpike, this is the first rock that shows itself as we ascend from the alluvial plain of New-Haven on the Humphreysville turnpike also, there is but a narrow stratum of chlorite slate separating it from the alluvion.

This greenstone often becomes stratified on both sides of the ridge, forming greenstone slate. At first, we perceive a partial and interrupted stratification; and in a few feet it becomes decided, extending through the whole mass. There is also frequently seen a double stratification; one set of planes crossing the other rectangularly or obliquely. Well characterized greenstone slate, however, is not abundant in Milford or West Haven. It usually soon passes into chloritic slate, or even into a bastard mica slate. An account of

these slates has been long since given to the public by Prof. Silliman in President Dwight's Statistical account of New-Haven, page 11. Their strata run N. E. and S. W. and dip to the S. E. The angle of depression below the horizon rarely exceeding 30° or 40°.

Let hand specimens of this primitive greenstone and of the secondary greenstone from East or West Rock be exhibited to a geologist who had never visited the localities, and he would not hesitate, I think, to pronounce that from East and West Rock to be primitive, and the other to be secondary; and for the reason, that he would find the secondary greenstone to be much the coarsest and most crystalline. The primitive greenstone of this locality is finely granular, and agrees, in this respect, with Jameson's description of transition greenstone. Indeed, it has already been suggested (Journal of Science, Vol. 2. p. 165.) that the Verd Antique of Milford *may possibly* belong to a transition series; and if so, this greenstone, greenstone slate, and chlorite slate, and even that bastard mica slate which is sometimes found between this marble and the secondary, may belong to the same class. The finely granular texture of transition greenstone, is however, by no means a distinctive character: since both the primitive and floetz greenstones are described as possessing the same.

The range of primitive greenstone in Northfield and Gill, commences about two miles north of the northern termination of secondary greenstone, and extends into Vernon. Its characters are very similar to those of the same rock at Whately and Milford. Some of it however approaches rather nearer the nature of sienite: but still the hornblende predominates. It is often stratified and often semi-stratified, becoming greenstone slate. Near the southern point I observed a vein or dike of limpid quartz several rods long and one foot wide, traversing this rock, having, a part of the distance, *saalbandes* of felspar.

The primitive greenstone occurring in Whately is somewhat different in its characters from that in Milford. It is coarse and usually highly crystalline in its texture, being sometimes rendered almost porphyritic by the imbedded peices of compact felspar, and sometimes being little else than pure hornblende. It is not extensive and alternates in one instance with sienite, the locality of which has been pointed out in treating of the latter rock.

The greatest part of this greenstone is greenstone slate, the strata having the same direction as that at Milford, and being nearly perpendicular to the horizon, ~~bearing~~ leaning a few degrees one way or the other occasionally. This slate is also more crystalline than the same rock at New-Haven. It is however a less degree of crystallization that chiefly distinguishes it from hornblende slate, towards which it verges and into which it probably passes. Notwithstanding the very decidedly fissile character of this slate, I have noticed in some instances a tendency in it to the trappose form; some of the specimens having a cleavage, like many crystals, in two directions, one coinciding with the direction of the strata and the other running across the strata. The proportion of felspar in this rock is small, often almost imperceptible. Chlorite, however, abounds as in the greenstone slate of Milford; and often it becomes real chlorite slate. Seams and beds of quartz are common in the Whately rock and also granular epidote.

Some of the rock colored, as hornblende slate in Shelburne, &c. much resembles certain varieties of this greenstone slate; and were the two rocks contiguous, it would be difficult to draw the line between them. Indeed, by some, this Whately rock would probably be denominated hornblende slate: but I think there is a distinction between the two rocks; and so long as any of the stratified rocks of Milford retain the name of greenstone slate, it would seem the Whately rock, from its resemblance and similar associations with unstratified primitive greenstone, demands the same appellation. An observer will be struck with the resemblance of the greenstone strata at these two places, and with their similar situation in regard to mica slate; and he will be disposed to enquire whether these rocks were not once continuous between these two places;—and in the intermediate space, he will find sufficient evidence in the great quantity of mingled detritus of other rocks, that the higher strata have suffered much from some levelling agent in former days.

9. Argillite.

Colored Brick Red.

The remarks last made in regard to the primitive greenstone, chlorite slate, &c. will apply to this rock. For we find it near the two terminations of the secondary tract and on the same side of it--viz. in Woodbridge at the south end, and commencing on the north at Leyden and extending at least as far as Rockingham, Vermont. The northern deposite is much the most extensive and is best characterized. In both places, however, it is often tortuous and slightly undulating, especially when passing into mica slate. It embraces numerous beds and "tuberculous masses" of white quartz—perhaps the milky quartz. The passage into mica slate is usually very gradual, the characters of the argillite losing themselves by imperceptible changes in those of the mica slate, so that for a considerable distance, the observer may be in doubt to which rock to refer the aggregate. The Woodbridge argillite occasionally alternates with mica slate, (Journal Sci. Vol. 2. p. 203.) and I have ascertained that this is the case also with that of Vermont. That which is just beginning to pass into mica slate, alternates also with a peculiar coarse limestone to be described under the next article; or rather, the limestone forms beds in the argillite—for instance in Putney.

A principal object in extending the map so much beyond the secondary region on the north, was to include all the argillite to be found along the Connecticut. Whether I have effected this object I am not certain. The Rev. E. D. Andrews, who communicated to me several facts on this subject, is of opinion that the northern limit of the argillite is on the south side of Williams' river in Rockingham, three miles north of Bellows Falls; but he had not examined the regions beyond with sufficient care to decide the point with certainty.

In Guilford, Vermont, this argillite alternates with a peculiar rock which Professor Dewey remarks appears "to be a talco-argillite with much quartz." Its stratification is less perfect than the argillite; or, rather, it has more of the irregularities and tortuosities of mica slate. Its small extent

and imperfect characters prevented my putting it down as a distinct rock. The stage road from Greenfield to Brattleborough passes over it in the southern part of Guilford. At the same place occurs well characterized chlorite slate; but not constituting any extensive range.

One mile south of this spot, another rock occurs, which an observer, at first sight, would pronounce to be granite. It is unstratified* and has the color of granite; but seems to be made up chiefly of quartz with a little mica interspersed. It seems to be an aggregate to which no particular name has as yet been applied; although the proportion of mica is so small that it might almost be called quartz simply. It appears to form a large bed in argillite, or talco-argillite.

The strata of argillite, both in Connecticut and Vermont, run in a direction nearly N. E. and S. W. and are highly inclined, generally varying but little from perpendicular. They are undoubtedly primitive—that is, the evidence of this is as great as in regard to the mica slate; both being highly inclined, and destitute of organic remains. Indeed, Bakewell, who has transferred argillite to the transition class, says "mica slate has a near affinity to clay slate; and as I have arranged the latter with rocks of the second class, it may perhaps be doubted whether mica slate should not also have been transferred to the same class." (Geology p. 83.) Do we not here see to what temptations the system maker is exposed, when pressed with difficulties? However, as Professor Kidd remarks,

* "By stratification we understand the divisions of a mass of rocks into many parallel portions whose length and breadth greatly exceed their thickness." *North-American Rev. No.* 29, p. 232.

"Where a rock is stratified, is it necessarily bounded by parallel surfaces? If so, let us hear no more of mantle-shaped, saddle-shaped, basin-shaped, trough-shaped stratification." *Greenough's Geology, Essay* 1.

I would beg liberty to enquire, whether some of these difficulties might not be removed by defining stratification to be the division of a mass of rock into many parallel or *concentric* portions? But after all, this, like a thousand other definitions in natural history, is only an approximation to the truth: For if mathematical exactness be essential, we have never yet seen any rock whose divisions were either parallel or concentric. Bakewell's distinction (Geology p. 31.) between "the structure which is caused by chemical agency, or by crystallization, and mechanical depositions," would perhaps give relief to some of the difficulties in regard to stratification, were geologists agreed what rocks have a structure caused by chemical agency and what ones are mechanical deposites. But they are not agreed on this point, as is evident from the very example he brings to illustrate his principle, when he says, that the division of slate rocks into layers, is the result of their chemical composition.

it seems "the terms primitive and transition are daily becoming of less importance."

Quarries have been opened in the Woodbridge argillite and it is employed in New-Haven for building. In Vermont also, they have been wrought in Guilford, and Vernon, two also in Dummerston, S. E. of the centre of the town, two in Putney, one and a half miles north of the meeting-house, and one in Rockingham, a mile north of Bellows Falls. In most of these the slate is of a good quality and easily obtained; but at present they are not much wrought on account of the little demand for it, and consequent low price.

10. Limestone.

Granular Limestone, Eaton, Index, &c.

Colored with India Ink.

This rock, in the country covered by the map, always exists in beds in mica slate and argillite: never occupying, however, so much as half the surface. I have colored it in that region where it occurs most abundantly, that is, in the mica slate nearest the argillite and the sandstone; although its beds exist in nearly all the mica slate north of Northampton on the west side of the river. It is remarkably uniform in its appearance. Its exterior, when it has long been exposed to the weather, is of a dark brown color, showing more marks of decomposition than any other rock in this region. The carbonate of lime is usually worn away at least an inch deep on the surface, and the silex and mica are left in coarse grains, or warts, or in projecting ridges. When newly broken the mica is uniformly of a light gray, and the texture is coarsely granular and dull, except the glimmering of scales of mica. The constituents of the rock are carbonate of lime, mica and silex, in somewhat variable proportions. In a specimen sent to Prof. Dewey, he found about fifty per cent of carbonate of lime and fifty of silex and mica. He judged that the silex constituted about thirty five per cent and the mica fifteen: and he judiciously adds, "the mica is in so great proportion, you cannot call it silicious limestone. At least, ought it not to be called a granitic aggregate, or silicious limestone mixed with mica?"

The beds of this rock vary in width from a few inches to 20 feet, and they rarely exceed this. They are unstratified, are sometimes traversed by veins of quartz, or more frequently granite, and sometimes the rock becomes so mixed with the mica slate, as to form one of its constituent parts. Rhombic crystals of carbonate of lime, of a yellowish brown color, and agreeing by goniometrical admeasurement with the primitive form, are found imbedded in this limestone, and sometimes these are connected with irregular masses of quartz, and larger plates of mica. It forms, when blasted, a good stone for underpinning. I have never seen it along the Connecticut, except in the mica slate at the northwest part of the map—nor in any part of New-England, nor in any mineralogical cabinet,—yet it seemed to deserve a place on the map, and a description.

11. Verd Antique.—*Cleaveland.*

Ophicalce Veinée. Brongniart.

Colored blue, and marked with oblique parallel lines.

The rich and elegant marble obtained from this rock has induced me to give it a place on the map, although its extent is very limited. It extends northerly from Milford harbour, 9 or 10 miles, apparently terminating two miles west of Yale College. It constitutes an extensive bed in chlorite slate, with which it sometimes alternates. I am inclined, however, to the opinion, that the slate lying immediately contiguous to the Verd Antique, although not well characterised, approaches nearest to greenstone slate. Yet, decided chlorite slate, appears usually only a few rods distant. In some places, the Verd Antique is a quarter of a mile in width, and forms ledges of considerable elevation and extent. It is stratified—the layers being thick and parallel to the slate rock enclosing it. The grain is fine; the rock is traversed by veins of calcareous spar, magnesian carbonate of lime, and asbestus; and is associated with chromate of iron and magnetic oxide of iron, diffused, more or less, through the entire body of the marble, and forming dark spots and clouds. The serpentine is twisted and entangled in the limestone in almost every form, and the green color of the rock may in gene-

ral be imputed to oxid of chrome—sometimes to the presence of serpentine, colored however, probably by the same oxid.

This rock has been extensively quarried in two places, one in Milford, 7 miles from New-Haven, and the other only $2\frac{1}{2}$ miles from the city. From these are obtained a marble which vies for elegance with any in the world. Indeed, in the extensive collection of marbles and porphyries in Col. Gibbs' cabinet in Yale College, we appeal to those who have seen them, whether any specimens exceed, or even equal in beauty and richness the Verd Antique from Milford. The varied clouding and shading of the gray, or blue ground of this marble with white, black, green, orange and gold yellow, indeed, with varieties of almost every color of the prism, give it an elegance that can be realized only by those who examine it. The working of this marble is difficult and expensive, and it is earnestly hoped that the patrician part of our community will not, by resorting to Europe for marbles, which, to say the least, are no more elegant than this, compel the proprietors of these quarries to abandon the undertaking. Specimens of this marble may be seen in most of the dwellings of the wealthy citizens of New-Haven; and many of the monuments in the grave yard of that city, are of the Verd Antique. Several chimney pieces of it may be seen in the Capitol at Washington.

Most of these facts in relation to this rock, I derive from the published accounts of it by Professor Silliman. (See Cleaveland's Mineralogy under Gran. Limestone, Marble, and Verd Antique, 2d Edit. Also, Journal Sci. vol. 2, p. 165.) A minute account of this interesting formation is still wanting; and Mr. Silliman has promised it. (See Jour. Sci. vol. 2, p. 166.)

12. Old Red Sandstone. *Werner. Cleaveland.*

It is agreed I believe among Geologists who have examined this region, that an extensive deposite of this rock exists along the Connecticut. (See Cleaveland's Mineralogy, 2d Edit. p. 759. Eaton's Index 2d Edit. p. 207. Tour between Hartford and Quebec, p. 21, and Maclure's Geology of the United States.) It is probably the oldest secondary rock in this region, and generally lies beneath all

the rest. So that it does not, I apprehend, occupy so much of the surface, as is generally supposed. There is much slaty sandstone, red and gray, and some of it very argillaceous, found along this river, which does not appear to be the old red sandstone of Werner; but to be a different formation, which I have denominated the Coal Formation; and which others have called gray wacke slate. I know of no instance in which I am certain that decided old red sandstone lies above the coal formation; although they evidently pass into one another. This coal formation, with the secondary greenstone and alluvion, occupies, I should judge, nearly two thirds of the secondary tract along the Connecticut; leaving not more than one third for the old red sandstone. This rock occupies the greatest extent of surface, as the map will show, in the vicinity of New-Haven. Along the western side of the secondary, it may be found all the distance, (occasionally covered by alluvion,) from New-Haven to Bernardston, Mass. Yet, it forms but few ridges or peaks of much altitude until we come to the south part of Deerfield. There it rises abruptly from an alluvial plain in the form of the frustrum of a cone, five hundred feet above the Connecticut; and the peak is called Sugar Loaf; being but a few rods in diameter at the top, and forming a striking feature in the scenery of the country. This is the commencement of a range, which, five miles north, rises 700 feet above the adjoining plain, and then slopes to the north, almost disappearing in Greenfield; but rising again in the northern part of the town and sending off one or two spurs into Gill.

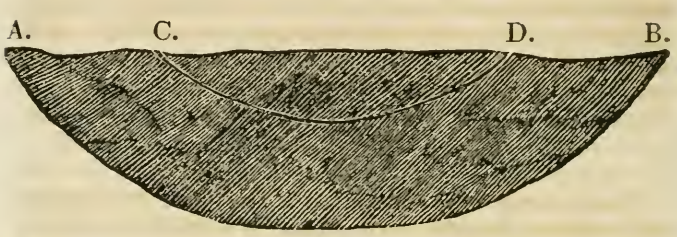
The grain, even of the finest variety of this sandstone, may be called coarse. Its colour is dark reddish, sometimes presenting spots or veins, of light gray, as in Hatfield, Mass. Its cement is argillo-ferruginous, and the rock usually exhales an argillaceous odour when breathed upon. It contains a large quantity of light gray mica, the plates being sometimes half an inch, or more, across, and inserted promiscuously. This description applies to the finest varieties of old red sandstone. But this passes into and alternates with conglomerates of the same general character and of various degrees of coarseness. The imbedded pebbles, vary in size from that of a musket ball to four or five inches in diameter. They are usually quartz, felspar, graphic

and common granite, and rarely gneiss or mica slate. The coloring matter of the rock, in most instances, has penetrated through these pebbles, giving the granitic nodules the same color as the rock, and the quartz a bluish aspect. This conglomerate frequently alternates with the sandstone, and one half of the layer of a rock is sometimes sandstone, and the other half conglomerate, no fissure being between them. Generally speaking, however, the puddingstone increases in quantity and coarseness as we ascend a mountain of this rock, and all the upper part of the hill is sometimes composed of it. Probably more than one half of the old red sandstone in the northern part of the range is this conglomerate: yet, as it is evidently a mere variety of the sandstone, it was thought altogether unnecessary to attempt a division by different colors on the map.

A considerable part of the range of this rock colored on the east side of Connecticut river, is somewhat different in its appearance from that I have been describing on the other side. At least, there is one very abundant variety that is not found on the west side. It consists of a fine, siliceous, red sand, adhering together with but very little visible cement. It has, however, an argillaceous odour. The coherence is not as strong as in the coarser sandstone, it being slightly friable. This rock may be seen in place in the southwest corner of Ludlow, and the east part of Long Meadow, Enfield, Somers, Ellington, &c.; and it forms a neater and handsomer building stone than any other rock of the sandstone family which I have ever seen.

A part of this range of red sandstone, east of Connecticut river, appears also to be verging towards the sandstone constituting the coal formation. Examples of this may be seen at the extensive quarry in Chatham, and also in Middletown—there seems to be a gradual passage of one rock into the other—and the strata of both these rocks have their dip in such a direction, as to lead one, at first, to conclude that this old red sandstone lies *above* the coal formation. The dip of both rocks is to the east. It does not follow, however, from this circumstance, alone, that the red sandstone does in fact repose on the other rocks. Thus, let A B be a profile crossing the valley of the Connecticut, and exhibiting the strata of old red sandstone, having

a dip as represented by the parallel lines. Let C D be a deposite of the coal formation lying upon the old red sandstone, the strata of which have the same dip. Now, to an observer passing along the surface from A to D, the red sandstone, between A and C, appears to lie upon the coal formation between C and D, whereas, the reverse is the fact. This might apply to the rocks we are considering in Connecticut, were it not for what I think to be the fact, that there is a gradual passage of the old red sandstone into the coal formation.



These, and some other circumstances, made me suspicious, for a time, that this range of sandstone east of Connecticut river, might not be the real old red sandstone, but a member of the coal formation ;—and it was not till I had traversed it the third time, that I felt entirely satisfied. But much of it certainly does not differ, at all as I could discern, from the old red sandstone on the western side of the river; and we find likewise the very same conglomerate. The strata also, are of a similar thickness and dip, varying as to the form, from six inches to two or three feet; and as to the latter from 10° to 30°; usually, however, not more than 10°. This dip, in all the red sandstone of the Connecticut, is below the eastern part of the horizon, with the single exception of a ledge that appears in the west street of Hatfield, where the dip is to the west.

This rock is extensively quarried for the purpose of building, in almost every town along the river. Noble specimens may be seen in the vestibules of the churches in New-Haven.

Organic Remains.

These are very rare in our old red sandstone. I found, however, in Deerfield mountain, one or two specimens that belong to the *petrifacta* of Martin; there being a perfect substitution of a finer grained sandstone for the original substance. I found only fragments, about four or five inches long, and they appear to belong to the genus *phytolite* of Gmelin's Linnaean System, and to the species *lignite*. They are a third of an inch in diameter, and a little flattened; and seem to agree with Professor Eaton's description of certain petrifactions found in red sandstone on the Catskill Mountain; (Index p. 211.) which he is inclined to refer "to the tribe of naked Vermes."

Fossil Bones.

These occur in East Windsor, east parish, one hundred rods south of Ketch's Mills. They belong to the *conservata* of Martin, and, without much doubt, to the genus *zoolithus* of Gmelin. The animal must have been about five feet in length, and lay horizontally in the rock, eighteen feet below its top, and twenty-three below the surface of the ground. The tail bone, as Dr. Porter, who lives near the spot, informed me, projected beyond the general mass containing the body of the skeleton, about eighteen inches in a curvilinean direction. This, of which that gentleman gave me a specimen, was easily distinguished by its numerous articulations. On exposure to the air, the bones begin to crumble and lose the appearance they presented when first dug up.

The rock in which these bones were found, is decidedly the old red sandstone. It agrees exactly with that rock as it exists at New-Haven, and to the distance of one hundred miles north from that town. The rock enclosing the bones is a little coarser than the finest varieties of this rock, and in the rock above the bones, was found some moderately coarse conglomerate. Whatever doubt I had with regard to some other varieties of rock in that vicinity, being the real old red sandstone, I could have no doubt in regard to this, after examining it.

13. Secondary Greenstone. *Cleaveland.*

Colored Carmine, or Rose Red.

To give the ranges of this rock, was one of the principal objects in constructing the accompanying map. For although it be an anomalous, it is a highly interesting formation. The high mural precipices that almost universally show their naked faces in the ridges and hillocks of this rock—the immense quantity of *débris* that frequently slope up half, or two thirds the distance to their summits—and the thin tufts of trees that crown their tops, form much of the peculiar scenery of the Connecticut. They remind the European of the basaltic and other trap ridges of Scotland, Ireland, Saxony, Auvergne, Italy, &c.

In regard to the greenstone* north of Hartford, I feel confident that every range of it to be found in place, is inserted on the map. South of Hartford some small and low hillocks of it may have been overlooked, notwithstanding all the assistance I have received from Prof. Silliman and Dr. Percival. For, in some places, this rock seems to be but a few feet in thickness above the sandstones, and to be less continuous than in the northern part of the map. In East-Haven and Branford especially, there are so many ridges of greenstone, and these so irregular, that it is difficult, on a map of such a scale, to make them all distinct and accurate.†

The most southerly point of greenstone on the map is the bluff in East-Haven, which fronts Long Island Sound, and is about one mile and an half north of the Light-House. The most northerly points of this rock are in Gill, ~~and in Northfield.~~ The greenstone which occurs in the upper part of Northfield, is more crystalline and of a coarser texture than in the intermediate distance, and is undoubtedly

* To save room, I shall omit, in the remainder of this article, the term secondary, as applied at the head of the article.

† There ought to be a geological map of the region about New-Haven, on a larger scale than the one I have given: and we could name more than one gentleman in that city, who is amply qualified for its construction.

primitive greenstone. Some of the specimens scarcely differ from pure hornblende.

Between the two extremities of granite above named, there is not a mile, except in Amherst, where this rock may not be found in some part of the valley of the Connecticut. The most continuous and lofty ridge is that of which West-Rock may be considered as the southern termination—although the west rock range is broken off a few miles between Mount Carmel and the Meriden or Berlin mountains. This ridge from West-Rock to Cheshire, presses hard upon the primitive rocks, often approaching the slate within a few rods. It presents, on the west, a lofty naked wall, appearing as if nature had erected this mighty rampart to guard the secondary region of the Connecticut from the encroachments of the primitive; while the great quantity of broken fragments along its base and scattered in abundance for four or five miles over the chlorite slate and argillite, evince that these ridges of greenstone were once much more elevated than at present. This range divides in the northern part of Hamden, the eastern branch forming Mount Carmel, and the western branch continuing into Southington, where it chiefly disappears, although immense bowlders of greenstone are scattered over the surface until we come to the north part of Farmington. Here the ridge again commences, and inclining considerably to the right, terminates in the north-east corner of Granby, Connecticut, in the Menitick or Manitick mountain, on the top of which runs the line between Granby and Suffield.

Mount Carmel terminates a little east of north from New-Haven, and until we reach the Meriden or Berlin mountains, the greenstone disappears. Commencing with these mountains, we find an almost uninterrupted ridge of greenstone, continuing into Massachusetts. Its elevation decreases, for the most part, as we go north, until we come to East-Hampton, when it suddenly rises, like the coil of a huge serpent, and forms Mount Tom, probably the highest point in the greenstone ranges of New-England. I do not know that its height has ever been accurately measured: but, comparing it with Holyoke, it cannot be much less than a thousand feet above Connecticut river. Connecticut river crosses

this range at the north end of Mount Tom, and on the opposite bank it rises again precipitously and forms Mount Holyoke. This I found, with a nice sextant, to be eight hundred and thirty feet above Connecticut river. North of Holyoke the greenstone is curved towards the right and continues of nearly the same elevation until it terminates near the north-west corner of Belchertown, having reached the primitive region.

Nine or ten miles north-westerly from this point, we find a narrow ridge of greenstone commencing, and pursuing a course considerably west of north, it passes through Sunderland, crosses Connecticut river, runs through Deerfield, crosses Deerfield river, and extending through a part of Greenfield, terminates at the falls in Connecticut river. A few rods east of this termination another range commences and runs east of north through Gill, with some interruptions, till it reaches its extreme northern point ~~in Northfield~~, two miles south of the primitive greenstone.

It will be seen by the map, that these greenstone ridges separate the old red sandstone from the coal formation nearly the whole distance from Berlin to Northfield; and the rocks of the coal formation are frequently found lying *above* the greenstone. The range of green stone in Sunderland is very narrow, and being in an unfrequented spot along the western margin of Mount Toby, it was a long time before I discovered its existence. Having once found it, however, it was traced, without much difficulty, except what an almost impassable precipice presented. It is from ten to eighty rods wide. As you ascend the mountain from the west, you first pass over a formation of old red sandstone, which is here a coarse pudding-stone. Next you come upon the greenstone, most of which is amygdaloidal, and is, so far as hand specimens will enable us to decide, the real toad stone of Derbyshire. Immediately east of the green-stone you find the coarse, brownish red, and the fine, fissile, argillaceous, gray and red sandstone slates of the coal formation. These uniformly rise in higher ledges than the greenstone; even one hundred or one hundred and fifty feet above it. As you pass along in the direction of the greenstone ridge, these precipices are not more than ten feet from you on one hand, and the greenstone at no

greater distance on the other. The broken fragments of the two rocks are confusedly mingled together, the sandstone breaking into large tables, and the greenstone into pieces only a few inches across. These huge tables are covered and fringed with a great variety of cryptogamous plants, such as various species of *Pamelia*, *Juggermannia*, *Sticta*, *Collema*, *Bartramia*, *Hypnum*, *Polypodium*, *Aspidium*, *Asplenum*, *&c.*; most of which are evergreen. And if the geologist be also a lover of this department of botany, he will find the wild and confused blending of such a variety of interesting objects to repay him amply for the labor and even danger of clambering over the fragments. I have never seen any rocks that seemed so congenial to the growth of cryptogamous plants as those constituting Mount Toby.

But to return from this digression. As the observer follows this greenstone southerly, commencing at its northern extremity on the banks of Connecticut river, and sees the lofty precipices of sandstone overhanging it, little doubt will remain in his mind that the greenstone actually passes under the sandstone. Yet any one acquainted with the anomalies of trap rocks will have the question arising in his mind, may not this greenstone, after all, here constitute an extensive dike? and he will hardly be satisfied until he sees the actual contact of the two rocks in place. One mile north-east of Sunderland meeting-house, the greater part of the greenstone ridge disappears and seems to run under the sandstone; but here a few feet of *dèbris* hide the actual junction. A little farther south an actual junction is seen; but the huge table of sandstone resting on the trap is removed a few feet from its original position. And, indeed, I never knew expectation so frequently disappointed, just at the moment when it seemed about to be realized, as in examining this range. It seems as if nature intended here to teach the geologist a lesson of patience. But, at length, one mile and a half south-east of Sunderland meeting-house, the observer comes to a valley worn by a brook, where finding the greenstone, which thus far has preserved almost a right line, widening towards the east, and forming a reentering angle in the sandstone, the angular point being in the brook; he will have little doubt that

the greenstone is here disclosed by the abrasion of the superincumbent sandstone—and on following the line of junction a few rods on the south side of the brook, he will find the sandstone in place lying directly on the greenstone, also in place. To one who has been accustomed to see this latter rock mounting above every other and monopolizing so muchspace forits broken fragments, it must be gratifying to see it at last pressed down by a superior stratum, and buried by the debris of a higher rock. In two places south of the point above described, other brooks have worn away the sandstone, and the greenstone forms in it a like reentering angle ; but the actual contact of the rocks is hidden.

But Sunderland is not, after all, the best spot for observing the rocks of the coal formation lying above the greenstone. I have been thus particular in describing the range of greenstone in that place, rather to exhibit the difficulties and *trials* to which the geologist is subject in examining the trap ranges of the Connecticut, than because it was necessary for this particular purpose.

Let the observer follow the Sunderland greenstone ridge northerly across Connecticut river into Deerfield, and he will here find it widening and increasing in altitude, presenting a mural precipice on the west, and a gradual slope on the east. Where it crosses Deerfield river it has every appearance of a vast dyke: although the sandstone rocks do not appear immediately in contact with it. From the top of the greenstone to the bottom of the river is more than two hundred feet. The range continues to the falls in Gill, where, as before observed, it terminates, and is succeeded by the red sandstone or conglomerate. And here would I mention another fact in regard to the greenstone and rocks of the coal formation. The latter do not merely lie above the former, but *they alternate with one another.* Let the observer pass round the northern termination of the greenstone range first mentioned, and follow down a small river called Fall river, to its mouth, and just at this point he will see the fine-grained, red, fissile, argillaceous sandstone of the coal formation, mounting up fifty feet upon the back of the greenstone at an angle of forty-five degrees. And if he follow down the west bank of the Connecticut

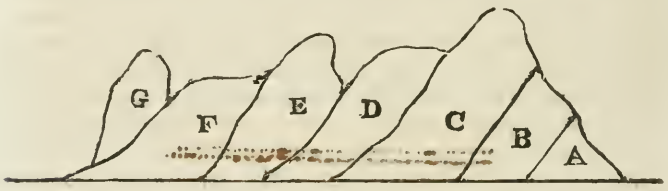
two miles, he will have repeated opportunities of observing the same fact; the river having worn away the rocks so as to afford a fine chance for observation: Let him now return and cross the mouth of Fall river eastward, following up the north bank of the Connecticut, and he will find the same red slate, cropping out about fifteen rods, when he will come to another ridge of greenstone, *under* which the slate passes. If he follows the junction of the rocks obliquely up the hill, on the east side of Fall river, a hundred rods in a northeasterly direction, he will observe the greenstone lying upon the slate more distinctly. Let him return to the bank of the Connecticut, where the sandstone slate passes under the greenstone, and he will observe them both extending in the same manner into the stream. If he now go eastward along the bank of the river, he will find greenstone twenty rods, and then the same or nearly the same slate, rising on the back of the greenstone at an angle of forty-five degrees. Thus will he have conclusive evidence of the alternation of these rocks. This alternation, crossing this same spot, is represented in the profile accompanying the map. No. 8 is the first ridge of greenstone above mentioned: No. 9 the sandstone slate, rising on its back: No. 10 the second ridge of greenstone; and No. 11 the second stratum of the slate. This second ridge of greenstone, as already marked, extends northeasterly into Gill and terminates in the west part of Northfield.

Another spot for observing the alternations of greenstone and the coal formation is one hundred rods south-east of Lyman's tavern, on the north-east side of Mount Tom, in Northampton. A small stream here crosses the road, and in its bed and banks several distinct beds of greenstone, some of them not more than one or two inches thick, may be observed at low water.

In the southern part of that extensive greenstone ridge extending from Amherst to Meriden, the sandstone of the coal formation may often be seen on the west side of the greenstone, lying underneath it. The shaft of the copper mine at Newgate prison passes through the greenstone and enters the sandstone: and Dr. Percival informs us (Jour. Sci. Vol. 5, p. 42,) that in Southington, "sometimes the sandstone can be very distinctly seen cropping out below the greenstone on the west side of the ridges." At the

outlet of Salstonstall's pond in East-Haven, I have observed a grey micaceous sandstone of the coal formation, passing under the greenstone with a considerable dip; and also two miles south of Durham village, on the side of the turnpike leading to New-Haven.

Dr. Percival, who has examined most of the greenstone ranges in Connecticut on foot, illustrates his views of the relative position of this rock and the coal formation as follows—referring particularly to the vicinity of Berlin. As you ascend the mountain ridges from the west, the lowest rock you find, after leaving the alluvion, is the old red sandstone, represented below by A. Above this lie the argillaceous sandstones of the coal formation, represented by B. The cap of the ridge C is greenstone; precipitous on the west side, but gently sloping on the east. Passing on we come to another stratum of the coal formation; as D. Next, perhaps, succeeds another ridge of greenstone, E—similar to C; and on its back, we find again the coal formation, F; And sometimes the cap of greenstone is insulated, as G.



Sometimes we find the greenstone resting immediately upon the old red sandstone, without the intervention of a third rock; as at East and West Rock near New-Haven.

From all that I have seen and learned concerning these rocks, I feel therefore, warranted in concluding, that, as a general fact, our greenstone alternates with, or forms beds in, the peculiar rocks of the coal formation; and it seems very probable that both these repose upon the old red sandstone. As the slates of the coal formation dip below the eastern horizon. it would seem we are furnished with the reason why the mural faces of the greenstone are almost universally on the western side of the ranges.

When greenstone rests on the coal formation, the lower part of the greenstone seems to consist of little else than a greyish black, indurated, ferruginous clay. Perhaps even

wacke* may be found lying between the greenstone and the sandstone, as at Gallows-Hill near Hartford, and on the west side of the Berlin ranges of greenstone. Some of the greenstone occurring in the dykes of this rock in old red sandstone, has a similar aspect. At the junction of the coal formation and greenstone below the falls in Gill, the columnar tendency of the latter rock entirely disappears, and for several feet, the greenstone is distinctly, though somewhat irregularly, stratified; the strata being parallel to the sandstone. This may be seen to most advantage at very low water; and the same may be seen, though less distinctly, along the whole eastern border of this range of greenstone ; and something of it on the east side of all the greenstone ranges along the Connecticut. It ought here to be remarked, also, that this rock appears quite different in its composition on the eastern side, especially of the range passing through Deerfield and Greenfield. The indurated clay seems in a great measure to take the place of the hornblende, and the basis of the rock has a wacke-like appearance. Much of it is amygdaloidal; but the imbedded minerals are usually quite different. On the east side, the most abundant is chlorite, having a radiated aspect, and green earth ; whereas, on the west side, this is scarcely to be found. The radiated zeolite on the west side is finely fibrous; on the east side, the crystals are larger and transparent, resembling the Thomsonite of Dumbarton in Scotland. The rock on the eastern side is, also, more decomposable than on the opposite side.

The eastern side of this rock is not, however, all amygdaloidal. Near where Deerfield river passes through the range, on the north bank, this rock contains distinct crystals, or rather plates of felspar; and thus becomes a porphyritic greenstone. "It even approaches to ophites," says Professor Dewey. The same rock contains good prehnite, and in the prehnite may be found pyritous copper.

I should judge that about one half of the greenstone of the Connecticut constitutes the base of amygdaloid, and very much of it appears to be genuine toadstone. The cavities are usually spheroidal or almond shaped, sometimes reniform, and frequently cylindric. Those of the latter

*I have recently found *wacke* perfectly well characterised, and very abundant, at the foot of the very lofty mural precipices, two miles north of Monte Video, on the Talcot mountain, ten miles W. of Hartford.—*Editor*.

form are often a foot or more in length, and arranged parallel to one another; the rock appearing as if bored through repeatedly by an augur. The imbedded minerals are calcareous spar, analcime, chlorite, quartz, chalcedony, chabasie, zeolite, and Professor Silliman has recently discovered gypsum* in a specimen sent him from Dr. Cooley; a new fact we believe in Geology, and one which renders it not improbable that this valuable mineral may be found in abundance along the Connecticut.

This amygdaloidal greenstone is probably most abundant at the lower part of the greenstone ridges; while the upper part is solid and usually columnar. Frequently, however, the columns are amygdaloidal to their top, and sometimes, as in Deerfield, in passing in the direction of the ridge, you will find alternate successions of amygdaloidal and solid greenstone columns. On breaking into the interior of the former, we often find them a rich reservoir of rare minerals. The cavities are usually small; but sometimes several inches in diameter, occupied by quartz and amethystine geodes, or chalcedony, or agates, or a peculiar pseudomorphorus quartz to be described when we come to treat of particular minerals. The largest and best agates occur usually among the greenstone that is not much amygdaloidal, sometimes occupying a cavity, part of which is in one column and part in another. They are very frequent, and some of those recently discovered by Dr. D. Cooley, in Deerfield, are probably the finest yet found in this country. A particular account of them will be given in the proper place. Prehnite sometimes forms a thin incrustration on the columns that are not amygdaloidal; and between the joints of those that are so, is sometimes interposed a thin coating of various minerals, among which epidote frequently predominates.

Some of the amygdaloid is very vescicular, bearing some resemblance to the slag of an iron furnace or lava. The cavities, in certain rare varieties, are various in form; and the base is whitish brown, reddish, and even brick red; containing, in the cavities, much prehnite, and this mineral, together with calcareous spar, seems, in some instances, to be mixed with the greenstone to form the base. An enthusiastic Huttonian would doubtless be gratified to find

*This gypsum was perfectly fresh—crystalized—white, and retaining its water of crystalization.—*Editor.*

such a variety. A locality of it may be found one hundred rods north of the Deerfield river bridge in Deerfield, at the western foot of the trap range.

The columnar tendency of our greenstone has often been noticed. It may be seen in almost every ridge in a greater or less degree, on the mural face—and these columns are sometimes remarkably regular. Good examples of them occur on the south-west face of Mount Holyoke; and still better ones a mile east of the village of Deerfield, a quarter of a mile north of the locality of chabasie, analcime, &c. mentioned in the Jour. of Science Vol. I. p. 115. They have from three to six sides, are articulated, the points varying from one to three feet in diameter, and of the same height, exhibiting handsome convexities and corresponding concavities. Half a mile south of this spot may be seen columns curving to the right and left as they ascend; thus forming a portion of an arch. The geologist, who traverses this ridge, can hardly avoid traversing in imagination the giant's causeway, Staffa and the Hebrides.

Some of the less perfect columns have a remarkably fissile tendency; forming good hand specimens of pseudo-green-stone slate. Globular distinct concretions of this rock are not unfrequent among the amygdaloid; composed of concentric coats of greater specific gravity than the rest of the rock. I have noticed them in Deerfield, and on the New-Haven turnpike between Durham and Northford, they are abundant, and from two to twelve inches in diameter.

The general aspect of our greenstone, where it has been long exposed to the weather, is reddish brown. When newly broken it is greenish, often somewhat lively. Sometimes it is greyish black, and, very rarely, has the color of a brick that has been burnt very hard. This variety is compact and the felspar imperceptible. It is often the fact, indeed, that the two ingredients in other varieties, are not to be discovered by the naked eye, or with an ordinary lens.

A question then occurs, whether some of the varieties of this rock are not genuine basalt? Certainly some of them answer the description of that rock, so far as external characters are concerned, to say the least, as well as of greenstone. And, indeed, if "greenstone and basalt may not unfrequently be seen passing into each other in the same stone, as D'Aubuisson and Dolomieu have observed," (Bakewell's Geology, p. 119,) there seems no rea-

son to doubt that this fact may exist in this country as well as in Europe. Were I to refer to particular localities for rocks resembling basalt, I should mention the foot of Mount Tom on the north-east side, and a part of the range passing through Deerfield. It would not surprise me, should future geologists make a division of our greenstone, calling a part of it basalt; dividing the upper part of the ridges from the lower, or the eastern side from the western, or both. A geologist, to be able satisfactorily to make these divisions, or to decide whether any of our rock is basalt, ought to have traversed extensively and observed minutely the like rocks in Europe; and, therefore, I leave the subject to abler hands.

A good locality for observing many of the varieties of greenstone above described within a narrow compass, is on the north bank of Deerfield river, about sixty rods from the bridge. Let a person cross the bridge to the north, and take the right hand road, until he comes to where the road passes round the end of the greenstone ridge. Here he will first see the most common variety, having a columnar tendency; and a few rods beyond, the reddish brown variety,* and in a wall, supporting the road on the right hand, he will find abundance of the porphyritic greenstone, having a somewhat stratified structure. Here, too, he will find some specimens covered with a ferruginous coating; so much charged with iron, indeed, that efforts have been made to smelt it. Indeed, a mass of four or five pounds from almost any part of this greenstone range, when held by the side of a compass, will move the needle.

It is not always the case, nor even generally, that the greenstone ridges that are marked as continuous on the map, are strictly so. They are often composed of numerous peaks or ridges, partially detached, but yet constituting a single range when viewed at their bases. And sometimes, when there appears to an observer passing along the western side of the range to be an uninterrupted wall, closer examination will show, that it is made up of several distinct ridges, so lapping on upon each other, and so near one another, that they appear continuous. The mural face of the ridges and hillocks is usually on their western side: but sometimes on the opposite side, as in the high moun-

*I have a specimen of greenstone from a vein in Scotland resembling this, except that the Scottish rock is much coarser.

tain between Durham and Northford; and sometimes on both sides, as Menitick mountain in Granby, Ct. Mount Carmel in Hamden, and Mount Tom in East-Hampton, at its southern extremity. The broken fragments of the greenstone, of almost every shape, seldom of any regular figure, and of various sizes, usually slope up more than half the distance from the bottom to the top of the ledge. This débris is highly interesting to the chronologist, because it furnishes him with a decisive

Cosmogonical Chronometer.

Every one who lives in the vicinity of these greenstone ridges knows, that every year adds to the loose masses at their base, at the expense of the columns above. The water infiltrated through the thin soil on their tops, finds its way into the narrow seams between the columns, and there freezes in the winter, and by its expansion, removes the rock a little from its place. This operation is repeated, year after year, and thus some part of the rock is pushed so far over the precipice that its center of gravity falls without the base, and it comes thundering down, usually dividing into very many pieces. Sometimes, if the foot of a column gives way in this manner, the whole column above, perhaps twenty or thirty feet long, is precipitated, like a glacier, on the loose rocks below. Sometimes only one or two of the lower joints fall out, leaving the principal part of the column suspended, the shuddering observer can hardly tell by what. He will also see evidences in very many places, both in the ledge above him and in the ruins beneath them, of recent instances of this kind. Indeed, in almost any place along these mural points, two or three of the outer columns are easily removed by the application of a lever, being loosened by the ice of preceding winters.*

Now every one must see that this levelling work cannot have been going on forever; and when we consider how

*On tearing down some of these columns a few years since, during the winter, in search of chabasie, &c. I found the spaces between them occupied by an immense swarm of the common *musquito*. Poor insects! it was all over with them as soon as the avalanche thundered. The Hon. Elihu Hoyt informs me he found a swarm of these creatures in the winter, in a hollow tree.

very considerable is the quantity of rock yearly detached, and compare this with the whole amount of the débris, the conclusion forces itself upon us that the period when this process began could not have been vastly remote; in other words, that the earth has not existed in its present form from eternity. Its precise age cannot, indeed, be determined by this chronometer; but I have often thought that, judging from this alone, we should be led to conclude that Moses placed the date of the creation too far back, rather than not far enough.

Greenstone Dykes in Old Red Sandstone.

Professor Silliman conducted me to an interesting locality of these in East-Haven. They occur on the main road from New-Haven to East-Haven, less than half a mile from Tomlinson's bridge. We measured their width, and that of the intervening sandstone, as they appear on the northeasterly side of the road. The road here passes over a small eminence, and the bank, on the north side, in its highest part, is almost fifteen or twenty feet above the road. The dykes, occurring at this place, are exhibited on the profile accompanying the map; and are laid down from a scale of fifty feet to an inch, with the intervening sandstone. In describing them I shall begin at the north western extremity, that is, at the point nearest New-Haven: but a person wishing to find them, will do best to go first to the other end of the profile; because the dikes are there more distinct.

No. 1. (See Profile.) Old red sandstone, coarse and containing pebbles so as to form a conglomerate. The dip of the strata is from 6° to 10° below the eastern horizon. The sandstone is very similar throughout.

No. 2. Greenstone dike, 4 feet thick.

No. 3. Sandstone, 114 feet. This distance was measured by pacing; the other distance by a rule.

No. 4. Greenstone, one foot thick.

No. 5. Sandstone, 9 feet.

No. 6. Greenstone, 9 feet.

No. 7. Sandstone, 40 feet.

No. 8. Greenstone, 10 feet. The soil has so covered this spot, and we having nothing with which to penetrate it, we did not actually see the dike. But the walls are distinct,

having small peices of the greenstone attached to them, and exhibiting somewhat of an altered appearance, like the other walls, so that little doubt could remain of this being a genuine dike.

No. 9. Sandstone, 52 feet.
No. 10. Greenstone, 5 feet.
No. 11. Sandstone, 45 feet.
No. 12. Greenstone, 10 feet.
No. 13. Sandstone, 19 feet.
No. 14. Greenstone, 7 feet.
No. 15. Sandstone, 7 feet.
No. 16. Greenstone, 4 feet. Here the greenstone is hid by the soil as is also the sandstone at the other end of the profile: so that by removing this, probably other dikes might be discovered.

Thus we have eight dikes in a distance of 21 rods. Some of them require a little attention to discover them; but most of them are very distinct. Some of them we traced several rods on both sides of the road, in a direction perpendicular to the profile. Their width is sometimes suddenly decreased, or increased, several inches, so as to form shoulders. They are not exactly perpendicular, but lean a few degrees to the west; and thus they are made to form an angle considerably obtuse on their eastern side with the sandstone. The latter rock is often somewhat glazed, having a specular aspect at the place of junction with the greenstone, and the two rocks are not unfrequently mutually impregnated, for several inches, with each other's properties.

I did not notice that the dikes at this place dislocate the strata of sandstone: but I paid little attention to this point.

Several dikes, similar to the above, (three at least,) occur in the old red sandstone on the right hand side of the turnpike from New-Haven to Middletown, on the east margin of the salt marsh lying east of East Rock. One of these is remarkably distinct, cutting through a precipice twenty or thirty feet high, and maintaining an uniform width of about a foot. This crosses the strata nearly at right angles; but makes an angle with the horizon of about 45° dipping to the south west. On its roof, or upper side, near the lower extremity, a part of the sandstone strata are thrown upwards two or three feet; and they are affected laterally about the

same distance. The dike along with the sandstone appears to pass under a hill of greenstone.

On the same turnpike, a few rods north-easterly of Northford meeting-house, four or five dikes occur; but they are so hidden by the soil as not to be particularly instructive. In passing from Durham to New-Haven on the same road, the first low ridge of greenstone, which we cross, exhibits something, which I was almost disposed to denominate a dike of coarse pudding stone, of the coal formation, in greenstone. Certainly, there appears a peculiar juxtaposition of the two rocks; but probably they exist in beds.

Two or three miles north of the dikes of which a profile is given, Dr. Percival found several others; and perhaps they are a continuation of the same. He found one also on the road from Farmington to Hartford in the rocks of the coal formation.

The greenstone found in these dikes has usually the dark compact aspect of basalt—resembling, however, much of the greenstone found along the Connecticut. Yet it seems to want the characteristics of greenstone, and specimens which I collected from the most perfect dike above described, half a mile east of East Rock, even approach to wacke. This rock gives an argillaceous odour, is of a greenish grey color, has an uneven fracture, is dull, and much softer than common greenstone; so that it may be cut with a knife:—and on comparison with a specimen of pure wacke from Calton Hill, (Edinburgh,) which was analyzed by Dr. Webster, it does not appear to differ, except in its greater hardness and perhaps less softness to the touch. I have little doubt that these dikes will ere long be denominated basaltic dikes: but, for the reason formerly alleged, I forbear to name them thus. They are an interesting feature in our geology, and deserve more attention; and it is peculiarly fortunate that they should be situated so near a geological school and the first mineral cabinet in our country.

Juxtaposition of Secondary Greenstone and Primitive Rocks.

The actual contact of these has never been observed along the Connecticut; and I know of but three places where there is a probability of finding the junction—viz. in the northeast part of Belchertown, in East-Haven and Bran-

ford, and in the east part of Woodbridge. So far as I have examined these places, I have always found a valley of geest between the rocks. But this is often very narrow; as for example half a mile west of Branford meeting-house, where granitic ledges lie on one side of the road and a greenstone ridge on the other. Further examination of this and the other points mentioned above, might discover associations similar to those occurring in the Hebrides.

Origin of Greenstone.

Does the greenstone of the Connecticut afford evidence in favour of the Wernerian or of the Huttonian theory of its origin? Averse as I feel to taking a side in this controversy, I cannot but say, that the man who maintains, in its length and breadth, the original hypothesis of Werner in regard to the aqueous deposition of trap, will find it for his interest, if he wishes to keep clear of doubts, not to follow the example of D'Aubuisson, by going forth to examine the greenstone of this region, lest, like that geologist, he should be compelled, not only to abandon his theory, but to write a book against it. Indeed, when surveying particular portions of this rock, I have sometimes thought Bakewell did not much exaggerate when he said in regard to Werner's hypothesis, that, "it is hardly possible for the human mind to invent a system more repugnant to existing facts."

On the other hand, the Huttonian would doubtless have his heart gladdened, and his faith strengthened by a survey of the greater part of this rock. As he looked at the dikes in the old red sandstone, he would almost see the melted rock forcing its way through the fissures; and when he came to the amygdaloidal, especially to that variety which resembles lava, he might even be tempted to apply his thermometer to it, in the suspicion that it was not yet quite cool. And without doubt he would see many a volcanic crater on the top of these ranges, where, with our dull eyes, we see only a pond or a quagmire. Even the occurrence of this greenstone in beds in sandstone would present no obstacle, since the discoveries by Dr. Macculloch in the isle of Skye of similar beds, of whin stone; concerning which he says, "there are no instances but where the alternating beds of trap detach veins or dikes from the lower to the upper beds;

or the trap, quitting the interval between two given beds of limestone or sandstone, makes its way across the one immediately above or below, and then proceeds with a regularity as great between some other pair of proximate strata"* (Transac. Geol. Soc. Vols. 3 and 4.)

By treating the subject in this manner I mean no disrespect to any of the distinguished men who have adopted either side of this question. To President Cooper especially, who regards the greenstone of the Connecticut as volcanic, I feel much indebted for the great mass of facts he has collected on the subject. And were I to adopt any hypothesis in regard to the origin of our greenstone, it would be one not much different from his. But I confess myself somewhat given to scepticism in regard to any general geological system extant; and Greenough on the First Principles of Geology has not aided much to remove my doubts. These systems have been productive of great good by spurring forward geologists to the collection of facts with a rapidity almost unequalled in any other science. When these shall be still farther accumulated, it is hoped and may be expected, that a second Werner will arise, who, having not merely the rocks of Germany but of the whole world before him, and following the inductive method of Bacon, will be able to construct a system of geognosy that will stand, like the Newtonian system of gravitation, on a foundation too firm to be moved. Perhaps such a system, after all, will prove to be an amalgamation of the theories of Werner and Hutton, and those names, which now form the watch words of opposing ranks, may descend to posterity, engraven side by side, in harmonious union, on the column that supports the system. If geological enquiries are not tending to this point we are much mistaken.

President Cooper was led from the profile inserted in the first Vol. of the Journal of Science, page 105, to conclude, the Deerfield greenstone to be a dike disrupting the old red sandstone. No distinction is there made between the sandstone of the east and west range; but since I have ascertained that on the one side is old red sandstone and on the oth-

* It is by no means improbable that similar connecting dikes may be found between the greenstone beds along the Connecticut. In all the places where I have examined these beds, circumstances were unfavourable for discovering the dikes had they existed.

er a sandstone of the coal formation, this greenstone must be regarded as a bed between them.*

14. Coal Formation.

Variety of Psammite. Brongniart.

Grey Wacke Slate. Eaton.

Colored brown by Umber.

It has long been known to mineralogists that coal was found along the Connecticut; and I denominate the rocks containing it the coal formation, simply because its beds occur in them, and in no other rock; the old red sandstone containing none at all, but lying *below* it. The coal formation embraces numerous varieties and sub-varieties of rocks, most of which alternate with one another and the principal of which are the following. 1. *Greenstone.* This strictly belongs to this class because it alternates with the other varieties and in Berlin contains coal. But there were sufficient reasons for giving it a separate color and description, which it is unnecessary here to mention. 2. *Trap. Tuff.* (*Trap Breccia*, Cleaveland.) This occurs on the east side of Mount Tom on the west bank of Connecticut river, and appears to lie between other rocks of the coal formation and the greenstone, and perhaps alternates with the greenstone; though I cannot say much as to its geological relations, as I have but recently discovered the rock and have had little opportunity to examine it. It consists of rounded or angular fragments of greenstone, quartz and sandstone, united by a reddish brown abundant cement of comminuted and decomposed sandstone, greenstone or wacke. Scales of mica appear scattered in the rock which seem to have belonged to the sandstone. It exhales an argillaceous odour, is difficult to break, and is about of the hardness of old red sandstone. The imbedded masses of greenstone are larger than the quartz or sandstone. I noticed some, six, eight, and even twelve inches across. Perhaps this rock is not the real trap tuff of Europe. If not, it certainly deserves the name of *greenstone conglomerate:* although many of the imbedded masses and

* Some other corrections needed to be made in the essay accompanying that profile and map. But as I intend to comprehend all that is important in that paper in this Sketch, a particular specification of corrections seems unnecessary.

the greenstone in the vicinity very much resemble basalt. The sandstone imbedded is that fine-grained argillaceous variety next to be mentioned. 3. *A red, very* fissile, *friable, argillaceous sandstone.* It generally contains small scales of mica and is abundant almost every where, frequently lying immediately upon the greenstone and alternating with it and with many other varieties of rock hereafter to be mentioned. 4. *A Gray Micaceous Sandstone Slate*, not argillaceous, grit coarse, very fissile, layers even, some varieties much resembling mica slate, others containing vegetable remains. 5. A similar slate; but much finer, harder and the layers undulating. 6. A slate approaching in appearance to shale, but very silicious, harder and very fissile, layers straight, surface not smooth, dark gray. 7. *Shale*, generally bituminous, very fissile, frequently micaceous with and without Ichthyolites. 8. A slaty rock of the aspect of shale, and sometimes much resembling coal, dividing into numerous small pieces of irregular form, and disintegrating when exposed to the air and moisture. At the falls in Gill. 9. A slate made up chiefly of indurated clay, sometimes micaceous, easily scratched by the finger nail, liable to disintegration. Falls in Gill, and cave in Sunderland, not abundant. 10. *A fragmented rock*, the fragments chiefly a reddish brown quartz, appearing as if burnt, cement silicious and apparently ferruginous, rock very hard, and appearing almost like porphyry, unstratified, not abundant. In Gill. 11. *Gray pudding-stone*, distinctly stratified, layers from six inches to a foot thick. Imbedded nodules, quartz, felspar and mica slate, rarely more than an inch in diameter, but very abundant, cement same minerals comminuted. Island in the falls at Gill. 12. *Reddish stratified pudding-stone*, coarser than the last, and scarcely differing from the conglomerate accompanying the old red sandstone. Mount Toby, Belchertown and Granby. 13. *Very coarse dark gray pudding-stone*, scarcely stratified. Imbedded masses often very large, even a foot in diameter, and very abundant, consisting chiefly of mica slate, argillite and chlorite slate; but containing quartz, hornblende, talcose slate, and sometimes granite, cement the same rocks comminuted. Gill, Montague, Mount Toby, and Durham. Most of the preceding rocks are often found alternating with one another. 14. *A gray imperfect limestone*, very silicious, in beds in sandstone slate, not fetid, not abundant, Gill. 15. *Fetid*

carbonate of lime. At Northford. I do not know its exact relative situation. 16. **Bituminous carbonate of lime*, in the coal formation at Southington and Middletown.

In this series of rocks, and in this only, has coal been found along the Connecticut. It occurs at Durham, Middletown, Chatham, Southington, Berlin, Somers, Ellington, Enfield, South Hadley, and Southampton. In most instances it is highly bituminous and burns freely. The seams of it are usually quite thin, rarely exceeding an inch in thickness, yet often they are numerous. In Berlin, the coal occurs in greenstone in a vein of crystallized quartz. (Journal of Science, Vol. 5, p. 44.) In Southington it is found in shale—in Somers, Ellington and Suffield, in friable argillaceous slate, (No. 3 above) in Enfield, in beds in gray micaceous sandstone; (No. 4. above) also in the same rock, ("granulated schistose aggregate" of Eaton, vide Journal of Science, Vol. 1. p. 136,) in the drift of the S. Hampton lead mine.

The Connecticut river, in its passage between the towns of Gill and Montague, has cut through the coal formation, except a single ridge of greenstone on the west, as may be seen by referring to the map. Through a considerable part of this distance, especially in the most interesting part, the bassetting of the strata is completely laid bare; and I have annexed to the map a profile of their order and dip, which I shall now proceed to describe. It is a vertical section, crossing the map at the falls in Gill and the strata nearly at right angles, extending on the west to the western part of Shelburne, so as to include a few other rocks beside the coal formation, and on the east, to the mouth of Miller's river. The chief object of this profile is to give a better idea of the coal formation than could be obtained by mere verbal description. That part of it, therefore embracing those rocks, is put down from a larger scale than the other parts, otherwise the numerous alternations could not have been represented. Especially that part between No. 8 and 40, is laid down from a larger scale than the rest of the coal formation, because this is the most interesting part of it and most distinctly laid bare on the north bank of the Connecticut, extending from the falls to the high greenstone ridge 100 rods west of it. This part was observed most attentively, and a quadrant converted into a clinometer, was used for determining the

* Bituminous marl slate?—*Ed.*

dip. The distances were all estimated by the eye, but it is presumed they will in general be found not far from the truth. From No. 1 to 56, inclusive, the stratified rocks all dip to the east, as is evident from the section. The Nos. included in parenthesis, refer to the general descriptions of the rocks of the coal formation in the beginning of the article.

No. 1. *Horblende Slate*—Strata highly inclined, often becoming an aggregate of hornblende, quartz and mica, having a porphyritic aspect.

No. 2. *Mica Slate*—Dip 20° to 30°, undulating and tortuous, passing on the east into argillite.

No. 3. *Limestone*—In beds in mica slate, already described in the preceding pages. Unstratified.

No. 4. *Argillite*—Dip 60° to 90°. The southern limit of this rock hardly reaches the line of the section : but a mile or two north, its relative position is as represented on the profile.

No. 5. *Old Red Sandstone*—With red conglomerate. Dip usually as much as 20°, being greater than is usual for this rock.

No. 6. *Alluvion*—A swamp.

No. 7. *Old Red Sandstone*—Dip between 20° and 30°.

No. 8. *Secondary Greenstone*—It is probable this forms a bed between the old red sandstone and the coal formation : but the former rock is never seen passing under it in this vicinity ; and, therefore, it must not be thus represented on the profile. Width about half a mile. On the eastern side it has, for a few feet in width, somewhat of a stratified structure.

No. 9. *Red, Fissile, Friable, Argillaceous, Sandstone, Slate*—(No. 3.) It is fine grained and often micaceous, of the color of brick, is easily cut by a knife, yields an argillaceous odour, has an undulating surface generally, and is liable to disintegration. This is probably the most abundant of the rocks of the coal formation; and it usually lies next to the greenstone and alternates with it. It is found over a large extent of country on the east side of the greenstone ridge, stretching from Amherst to Berlin; although in Connecticut it more frequently is wanting in the mica and its surface is more uneven. It forms much of the flagging stone in Hartford and exists in place a foot or two below the surface in that city; though it seems here in some instances to approach to the nature of shale. The surface of the layers often appears a little glazed and is sometimes traversed by numerous little ridges a mere line in thicknes and of the

substance of the rock, which I have sometimes suspected might be petrifactions; and perhaps they are so. When this rock is disintegrated it forms an admirable material for the construction of roads; a good example of which may be seen in the road between Hartford and Weathersfield.

Where the profile crosses this rock, it has a dip of 45° ; and as already observed under the article greenstone, it here mounts upon the back of the greenstone forty or fifty feet. If we follow the junction of these rocks southerly, on the west bank of the Connecticut, we shall find *the slate conforming to the irregularities of the greenstone*, thus forming saddle shaped strata. In some instances we notice a sudden curve from this cause, of 90°. At the first copper mine we find on passing down the river, a narrow spur of the greenstone extends a short distance into the slate, and the vein of ore here passes from the greenstone into slate. Half a mile south of this point we find the slate crossed obliquely to the direction of the strata by parallel seams dividing it into strips from one to six inches wide and often five feet long. Sometimes we find in these divisions six sided prisms of quartz, lying partially imbedded and exhibiting both terminations in great perfection. I have seen seams very narrow containing green carbonate of copper, the sides of the vein being beautifully glazed, having a highly specular aspect, and forming the *saalbande* of the Germans. The width of the rock on the section is about fifteen rods, extending across the mouth of Fall river.

No. 10. *Greenstone*—(No. 1.) This has been already described when treating of that rock. Thickness of the formation, 20 rods.

No. 11. Same as No. 9. (No. 3.) Thickness of the stratum, 6 rods, dip 45°.

No. 12. *Red Slate*—resembles the last, but is more micaceous, is divisible into thinner laminæ, the surface of which is even, and the color is less red. A beautiful rock. Thickness 6 feet, dip 45°.

No. 13. *Reddish micaceous sandstone*–Somewhat conglomerated, the imbedded pebbles of quartz and flesh colored felspar, small and rounded, less fissile than the last, layers thicker. Thickness twelve feet, dip 40°.

No. 14. Same as No. 12. Thickness 15 feet. dip 40°.

No. 15. Same as No. 9. Thickness 15 rods, dip 40°.

No. 16. *Reddish gray, friable, argillaceous sandstone slate*—Irregular, tortuous, disintegrating at the surface, a little micaceous, containing numerous small specks of carbonate of copper, and appearing to be an imperfect copper ore. Thickness 4 feet, dip 40°

No. 17. *Hard, compact limestone*—(No. 14.) Fracture dull, containing a large proportion of silex, feebly effervescing with the acids. Thickness of the stratum only a foot, dip 48°, not divisible into layers. This very imperfect and small bed of limestone is the only locality of limestone rock I have ever found in the secondary region north of Hartford.

No. 18. *Gray, Micaceous sandstone slate*—(No. 5.) Irregular, tortuous and undulating, not as easily and as handsomely separating into layers as the red slate, resembling some varieties of the mica slate, scarcely argillaceous. Thickness 6 feet, dip 40°.

No. 19. Same as No. 9. Thickness 12 rods, dip, 43°.

No. 20. *Coarse, reddish conglomerated sandstone*—Containing imbedded pebbles. Scarcely different from No. 13, except somewhat coarser. Thickness 6 feet, dip 43°.

No. 21. Same as No. 12. Thickness 3 rods, dip 43°.

No. 22. *Gray, micaceous, sandstone slate*—Rough to the touch, coarse, granular, scarcely argillaceous, not separating into so thin layers as the red slates. Surface not undulating or tortuous. Thickness 15 feet, dip 43°. An excellent flagging stone.

No. 23. (No. 9.) *Soft argillaceous slate*—Surface smooth, scarcely undulating, divisible into thin plates, easily scratched by the finger nail, and consisting of little else than clay moderately indurated. Thickness 5 feet, dip 45°, easily disintegrated, rarely micaceous.

No. 24. *Gray micaceous sandstone slate*—Similar to No. 22, but softer to the touch and finer grained, more undulating and divisible into thinner layers, containing vegetable remains converted into perfect coal. These were so numerous in one spot, that I thought I had found a bed of coal. Thickness 3 rods, dip 40°.

No. 25. *Geest*—2 rods.

No. 26. *Shale*—Color very dark, containing sometimes small scales of mica, surface a little knobby, containing abundance of sulphuret of iron and spheroidal nodules from half an inch to two inches diameter, of *argillaceous iron ore?*

very similar to the shale containing the ichthyolite at Sunderland. Thickness 1 rod, dip 40°.

No. 27. Same as No. 24. 2 feet thick, dip 40.°

No. 28. A stratum of coarse grayish sandstone, or rather conglomerate, 2 feet wide, dip 40°.

No. 29. Same as No. 24. Thickness 5 rods, dip 40°.

No. 30. *Geest*—10 feet. It may be well, perhaps, here to remark, that shale usually forms the roof and floor of coal beds, and that this geest and that of No. 25 lie immediately below shale. Connect this fact with another, "that the seams or strata of coal rise up to the superficies of the globe as well as all other strata, only they do not always push up so boldly to the very surface of the ground as many hard stones and other indurated strata are found to do; for on account of the tender and more friable texture of the coal, the superficies of the stratum is often mouldered down and lies concealed under a thicker or thinner bed or cover of clay, gravel, sand, or earth." (Williams Mineral Kingdom, Vol. 1. p. 135 2d edition.) If then coal can be found along the section here described, (which I suspect to be quite doubtful,) the best spots to search for it are Nos. 25 and 30.

No. 31. *Shale*—10 feet thick, dip 40°, containing abundance of nodules of *argillaceous iron ore*? Rock rather hard for pure shale, not liable to much disintegration.

No. 32. *Coarse, gray, sandstone or conglomerate*—Rock harsh to the touch, imbedded masses not large, layers thick. Thickness two rods, dip 40°.

No. 33. Same as No 24. Thickness 3 rods, dip 43°.

No. 34. *Shale*—Alternating with, and passing into, a bluish, gray, fine grained slate, harder than the shale, though perhaps only a variety of it. A little micaceous. Thickness 3 rods, dip 43°.

No. 34. *Blackish gray slate*—Similar to that mentioned under the last No. but less fissile and much harder, indeed, it breaks with nearly as much difficulty as greenstone, and where it is worn by the water it somewhat resembles that rock. For it contains numerous irregular cells, sometimes two inches in diameter, formerly filled, probably with *argillaceous iron ore*? On breaking the rock its structure is slaty and it is a little micaceous. Thickness 2 feet, dip 40°.

No. 36. *Coarse grayish sandstone or conglomerate*—like No. 32, layers 2 feet thick. Thickness 20 feet, dip 40°.

No. 37. *Red slate*—As No. 9, but harder and coarser and less irregular on the surface of the layers. Thickness 3 rods. dip 40°.

No. 38. Same as No. 22. Thickness 20 feet, dip 40°.

No. 39. Similar to No. 38, but more micaceous and divisible, into thinner layers; resembles much, certain varieties of mica slate, except that the silex has a more earthy aspect. But it would not be difficult to deceive almost any geologist by labelling hand specimens, mica slate. Thickness 2 feet, dip 40°.

No. 40. Same as No 37. Thickness 10 feet, dip 40°. This carries us to the dam across the Connecticut.

No. 41. *Hard gray sandstone slate*—Like No. 22, but more undulating and irregular. Thickness 5 rods, the remaining distance the scale is much reduced.

No. 42. Very near No. 41, but coarser and not so undulating. Thickness 8 rods.

No. 43. *Coarse gray conglomerated sandstone*—layers thick. Thickness 12 rods.

No. 44. Same as No. 40. 3 rods thick, dip 35°.

No. 45. *Alluvion*—20 rods.

No. 46. Same as No. 32, about 2 rods thick.

No. 47. Same as No. 40, 1 rod thick.

No. 48. *Alluvion*—a quarter of a mile; beyond this the section is continued on the south bank of the river.

No. 49. Same as No. 37, one half a mile.

No. 50. (No. 10.) *A singular fragmented rock*—unstratified, 20 feet thick, very hard and tough, imbedded fragments, chiefly reddish brown quartz, appearing as if it had undergone the action of fire, a little micaceous, cement often blackish, appearing like veins, apparently ferruginous, rock resembling some varieties of porphyry.

No. 51. (No. 6.) *Dark gray, very fissile sandstone slate*—Harder than shale, somewhat argillaceous in its odour, a little micaceous, surface rough and grit coarse, slightly sonorous when struck, 1 rod thick, dip 40°.

No. 52. Same as No. 50, 1 rod thick.

No. 53. Similar to No. 39, 5 rods thick.

No. 54. Alluvion between half and three quarters of a mile.

No. 55. Same as No. 9, half a mile.

No. 56. Same as No. 51, extending nearly a mile, dip at first 35°, but gradually decreasing to 15°. The direction of the strata of this rock is quite different from the other varieties, which generally have a direction between north and northeast. But this variety is so much wheeled that it runs not far from east and west; and in passing up the river we sail for a time nearly parallel to the direction of the strata. I do not see why this rock might not be employed for roofing; and if so, the situation of the quarries would surely be very advantageous.

No. 57. Same as No. 9, strata nearly perpendicular, but leaning a little to the east, and their direction nearly the same as that of all the varieties mentioned except the last. Thickness 10 rods.

No. 58. (No. 8.) *Blackish tortuous slate*—Stratification irregular and the layers dividing into numerous shapeless pieces by fissures in every direction. The surface of these amorphous pieces is frequently a little glazed. Rock, friable, scarcely micaceous, argillaceous, strata leaning a few degrees to the east, 20 rods thick. This rock forms a bed at the island in the falls in the Connecticut three miles below this spot, and there it is exposed to the occasional action of the water and is disintegrated so as to leave the superincumbent strata projecting over it several feet, and it very much resembles impure coal: but I could not determine that it contains any. It is probably a variety of shale.

No. 59. *Very coarse, dark gray puddingstone*—A general description of this rock has already been given in the beginning of this article. (No. 13.) Imperfectly stratified at this place, rather harder than the old red sandstone conglomerate, yet appearing as if composed of little else than a mass of pebbles, the cement being not abundant, extending at least a quarter of a mile. The Connecticut at this place has worn a passage between this rock and the primitive, and high ledges appear on both sides of the river, which, on comparison, seem to differ almost *toto coelo*. The puddingstone extends through Montague, sometimes assuming a reddish aspect, and in Sunderland forms a considerable part of Mount Toby. Here it alternates with the red and gray slates above described; and it is curious to observe the frequent sudden changes from this coarsest of conglomerates to fine grained slates.

Where the profile crosses this rock, some of the imbedded masses appear at their surface as if they had undergone the action of fire. On breaking a mass of gray quartz containing a little mica, a zone of half an inch wide appeared at the outer edge, of a brick colour, indicating a chemical change either by fire or water, for the specimen was sometimes covered by water.

I have observed little of this peculiar puddingstone in Connecticut, though so abundant in the northern part of the coal formation. It appears, however, in the south part of Durham.

No. 60. *Geest*—covering a narrow valley.

No. 61. A narrow stratum of gneiss.

No. 62. *Granite*—This does not appear in abundance on the bank of the river. The best spot for examining it is half a mile south, where it forms a hill 100 or 200 feet high.

From the preceding description of this profile, it appears, that after crossing the first ridge of greenstone there is a gradual decrease of the dip from 45° to 15°, and after passing this point, which is not exactly central, but nearer the granite than the greenstone, we find the dip in *a contrary direction*, and almost 90°. Precisely such would be the effect, the Huttonian would say, if we suppose the granite and the greenstone to have been forced up through the strata by a subterranean fire, after these strata were consolidated. And we might expect, also, that this convulsion would produce that wheeling of the strata observed in the central parts. There is something peculiarly striking in this explanation, and an inquiry arises, whether any corresponding facts occur in any other part of the coal formation. At mount Toby, a few miles south of Gill and the highest point of the coal formation, the strata dip to the east at an angle usually less than 10°. And here the greenstone ridge on the west is small, but the granite on the east, at no great distance, is abundant. On the south east side of Mount Holyoke in Belchertown and Granby, the strata dip to the south east, near the mountain, at an angle not less than 45°, and the greenstone ridge here is large. But the rocks that lie on the back of Mount Tom, the highest point of greenstone along the Connecticut, have a dip not generally larger than 20°. And the same remark will apply to many greenstone ridges in the accompanying coal formation in Connecticut.

The highest point of the coal formation is Mount Toby in Sunderland, which rises between eight and nine hundred feet above the Connecticut. Beginning at Whitmore's ferry, the locality of the ichthyolites, to be hereafter described, and passing up the mountain obliquely to the south-east, we find alternations of most of the rocks described in the above profile. The different varieties of conglomerate are most abundant, and cannot, except that variety which is reddish, be easily confounded with the conglomerate accompanying the old red sandstone. They differ from this latter rock, 1. By being of a light or dark grey color, sometimes a little red. 2. In the greater abundance of imbedded nodules, and less quantity of cement. 3. In the different nature of these nodules, those in the old red sandstone conglomerate being chiefly quartz, felspar and granite, and those in the coal formation pudding-stone, being chiefly mica slate, argillite, chlorite slate, talcose slate, and quartz with felspar and granite rarely. 4. The coal formation pudding stone often contains thin incrustations of carbonate of lime in the seams and crevices. The red sandstone is wanting in this.

As a general fact, I feel prepared to state that the rocks of the coal formation *lie above* the old red sandstone. In most cases these rocks are separated by greenstone, so that their exact situation cannot be easily ascertained. Along the western face of the greenstone ridge, extending from Meriden into Massachusetts, the rocks of the coal formation are often seen cropping out below the greenstone; and the old red sandstone occurs at a still lower level. This may be seen in the space of a few rods in descending the hill northerly, from Newgate prison; and although the actual junction of the rocks is not here observable, yet they appear only at short distances from one another. The fact, that the coal formation alternates with greenstone, and that this latter rock always lies above the old red sandstone, is a strong presumptive argument that all the coal formation lies above the old red sandstone, and conclusive evidence that a part of these rocks lie above it. The situation of the rocks about Middletown, Chatham, &c. which might be urged as an objection to this fact, has been already considered, and I leave it for further examination.

There are many instances, also, in which the rocks of the coal formation *pass into the old red sandstone.* Let a person go to the mouth of Fall river in Gill, where, as already described, he will find the red argillaceous sandstone slate of the coal formation cropping out below the greenstone. Let him ascend Fall river, and he will find this slate becoming coarser, the layers thicker and the aspect changing, until, within a mile and a half, it becomes decided old red sandstone or conglomerate; the dip, also, diminishing. Or let him follow the road that leads from the mouth of the river to Greenfield, and as he ascends the hill, he will observe a gradation from the slate above named into decided fine grained red sandstone. Much of the rock occurring along the east side of Connecticut river in Somers, Ellington, Chatham, in Middletown and Durham, appears to be intermediate between old red sandstone and this slate of the coal formation. Even in Somers and Ellington, where a strip is marked as coal formation, I found little else but this intermediate rock. But as coal has been found there, (Am. Journal of Science, vol. 3, p. 248,) a strip has been colored brown, rather to mark out the locality than the extent, of the coal formation. It is not improbable that some more experienced geologist than myself, may hereafter include the rock I have marked old red sandstone on the east side of Connecticut river as one of the members of the coal formation—but I could not do it without doing violence to my own convictions.

It may be of importance in a geological view to mention the veins of copper ore so frequently found along the Connecticut greenstone ranges. All these veins which I have seen, or of which an account has been published, are found on the margin of the greenstone and coal formation; and *the veins always pass, either laterally or perpendicularly, from one rock into the other.* They are quite numerous, and we have already remarked that copper ore and iron pyrites are not unfrequently disseminated in the slates.

To avoid mistake: I will just mention different spots on the map that are colored as the coal formation. 1. A large extent in Gill, Montague and Sunderland; 2. In Granby, Mass. and Ludlow; 3 A small patch in Somers and Ellington; 4. An extensive range extending from West-Springfield to Berlin; 5. In Hartford, Westhersfield, Mid-

dletown and Durham; 6. A small patch in East-Haven; 7. A narrow range in Southington; 8. The same in Westfield and South-Hampton. The latter, in the northern part, is penetrated by the drift to the South-Hampton lead-mine; but scarcely appears at the surface. In Westfield, however, it is wider.

It would seem from the preceding description that all the rocks essential to Werner's Independent Coal Formation are to be found along the Connecticut, viz. a friable micaceous sandstone, shale and pudding-stone, (Cleaveland, vol. 2, p. 508,) and also the greenstone and amygdaloid Professor Jameson has added. Still, however, there are some other circumstances which may leave the geologist in doubt whether the real independent coal formation occurs along this river.

Some may suppose the rocks above described to be grey wacke and grey wacke slate; and if the definition of grey wacke be so broad as to include those pudding-stones *whose cement is merely a comminuted portion of the imbedded fragments*, it will indeed include not only the pudding-stone of the coal formation above described, but, for aught I can see, *even the old red sandstone;* and, indeed, what fragmented rock will it not include?* And besides, many of the argillaceous sandstone slates described above, cannot, without difficulty be distinguished from certain varieties of grey wacke slate in hand specimens. But the rock usually called grey wacke in Europe has never yet, I believe, been found lying above the old red sandstone, as does the coal formation along this river. It is usually traversed, says Jameson, by quartz in the form of veins, which is rarely, if ever, the case in our rock. It has never been found alternating with beds of any sort of coal, except the coal blende; but our rock contains many beds and veins of that which is highly bituminous. Again, the icthyolites and other organic relics that are found at Sunderland have almost all the rocks of the coal formation lying above them, as may be seen by the sketch of Mount Toby, that will be given when we come

*Some judicious remarks on this subject are contained in the North-American Review, No. 29, p. 235. There we find the following sentence concerning the Roxbury and Dorchester plumb-pudding-stone, which somewhat resembles a certain variety described above. "This rock forms one vast bed, which we have examined in various parts and feel no hesitation in saying that it is not the grey wacke of European geologists."

to describe these remains. But in other countries "these fossil remains of fishes are found only in strata of very recent origin." (Rees. Cyc. Art. Icthyolites.)

The great dip of many of these rocks may be thought to afford evidence of their being older than the old red sandstone, or the independent coal formation. But to show that the dip of rocks is a very equivocal criterion of their age, I need only to refer to the recent work of Greenough on the first principles of geology. And besides, it is no uncommon thing in real coal fields for rocks to be highly inclined. "This inclination or dip of the (coal) strata is found every where; in some places it varies very little from the level; in others considerably, even so much as to be nearly in a perpendicular direction;" (Rees Cyclopedia, Art. Coal,) and still farther, as already hinted, there is reason to believe that Mount Toby, the strata of which are almost horizontal, exhibits the original dip of these rocks, and that those cases in which they are more highly inclined are the result of some Plutonian convulsion. Such irregularity in the dip of coal fields is no uncommon occurrence. "In some coal fields," says Mr. Williams, (Nat. Hist. Min. Kingd. vol. 1, p. 93,) "the strata acquire this horizontal and waving position, and afterward, towards the south-west or toward the north-east, the declivity becomes again so steep as to form an angle of 45°, and in some particular instances to approach still nearer to the vertical position." Upon the whole, I think there are insuperable objections against referring the rocks of our coal formation to grey wacke and grey wacke slate.

Another opinion already advanced on the subject is more probable. It is that of Mr. Brongniart, who gave it after having seen only the rocks containing the Westfield fish impressions. "This formation," says he, "appears to me to have the strongest resemblance to that of the bituminous marl slates of the copper-mines in the country of Mansfield and Hesse." (Journal of Science, vol. 3, p. 220.) The arguments in favor of such an opinion are, 1. The great similarity in the appearance of the German and American rocks on which the fish are found—one species, at least, being the same in both. 2. The occurrences of copper ores, and similar ones too, along with native copper in both rocks. 3. The fact that both these varieties of rocks lie immediately above the old red sandstone. Perhaps there are oth-

er points of resemblance, but I have not been able to find any minute account of the bituminous marlite formation.*

On the other hand it may be said that no real bituminous marlite occurs along the Connecticut—provided the grand distinction between this rock and bituminous shale consists, as Professor Cleaveland says, (Mineral. vol. 1, p. 191,) in its effervescence with acids; for our rock, certainly that at Sunderland, does not effervesce with acid, unless it contains, as it sometimes does, a slight incrustation of carbonate of lime. Mr. B. does not consider the occurrence of thin beds or veins of coal as opposed to his opinion; but the strata penetrated at Riegelsdorf in Hesse, in order to reach the fish impressions, are totally different from those occurring along the Connecticut. They are as follows: "No. 1. Ferruginous clayey mould, from one to two fathoms. No. 2. Greyish white limestone, from six to eight fathoms. No. 3. Blue clay, with imbedded fragments of selenite crystals, from eight to ten fathoms. No. 4. Bluish limestone, called *Rauchwacke*, from eight to nine fathoms. No. 5. Grey compact gypsum, traversed by ferruginous loam, from seven to eight fathoms. No. 6. Black and grey stinkstone, from one to one and an half fathoms. No. 7. Sand, sometimes loose, sometimes cemented, from one to one and an half fathoms. No. 8. A kind of limestone, called *Zechstein*, of a greyish brown color, and soft above towards the sand, but blacker and more compact below; from three and a quarter to three and an half fathoms. No. 9. A black slaty stratum, containing pyrites and forming the roof of the bituminous marl slate, from eighteen to twenty inches. No. 10. Black cupriferous bituminous marl slate, from three to eight inches: this is the principal depository of the icthyo-

*Extract of a letter from Dr. J. W. Webster:—

"The bituminous marl slate has been one of the most troublesome rocks for years: some have placed it here and some there. From its effervescence with acids we should perhaps more properly put it among the limestones. Again, from the richness of some specimens of it in copper, they would be classed as copper ores—indeed, we know that it is worked for copper. It occurs in the secondary limestone. Its external characters are very little different from those of bituminous shale of the coal formation; but from all I have learned of it, I am pretty well satisfied that it is distinct from and *above* the rocks of the coal formation. You will note one striking difference between the two—vegetable impressions are abundant in bituminous shale of the coal field; but rare in the B. M. slate—it is more abundant in fresh water remains."

lites. No. 11. Gneiss like greyish white rock, consisting of small rounded quartz pebbles, and sometimes of copper and mica, cemented by indurated clay. No. 12. Old red sandstone, or the dead rock, being the fundamental rock of these floetz strata." (Rees Cyc. Art. Icthyolites.)

Under these circumstances I have thought it safe to denominate the peculiar rocks under consideration along the Connecticut, the coal formation. A more complete set of them has been forwarded to Mr. Brongniart, and we wait anxiously for his final opinion. The suspicious circumstances attending them and the occurrence of the coal hitherto discovered in thin beds and veins only, render it very doubtful whether extensive beds of this valuable mineral will ever be found in them. They have been unsuccessfully explored at South-Hadley, Southington and Westfield, Ct. But I would not wish to discourage further search. The decision of the question above discussed, concerning the precise rank they ought to hold in the rock formations of the globe, is one of considerable importance, since it will depend on that decision whether coal or copper or gypsum may be sought after with the greatest prospect of success. They have long been to me a fruitful source of perplexity, and again and again have I returned from traversing them in utter despair of ever determining their real geological relations. To denominate them the coal formation relieves, for a time, most of these difficulties: but that name will cheerfully be resigned whenever a more correct one shall be proposed.

Organic Remains in the Coal Formation.

1. *Icthyolites.*

These occur at Westfield, Ct. and at Sunderland, Mass.; and it is said also at some other places, as at West-Springfield; but I have never seen any, except from these two localities. At Westfield they were found in exploring for coal, lying upon bituminous shale. Two species at least were recognized, one of which Mr. Brongniart calls the *Palœthrissum freislebenense* of Blainville. These impressions have been so repeatedly and accurately described by Prof. Silliman in Cleaveland's Mineralogy and the American Jour. of Science, that it is unnecessary to be more particular.

At Sunderland these impressions occur in bituminous shale, which often contains a little mica, and generally a quantity of iron pyrites, disseminated through the rock. They occur at Witmore's ferry in the north part of Sunderland, in the bank of the river. They are found most abundant at the lowest water mark, at which time two men, in less than half a day, dug out for me nearly fifty specimens. Sometimes a layer of semi-crystalline dark colored carbonate of lime, less than one twentieth of an inch thick, lies between the layers of slate. The substance of the fish is usually converted into coal, the thickness of which is rarely more than one tenth of an inch in any part, and the color is black. In some instances, however, the carbonate of lime above mentioned covers the fish, and has taken the place of the matter of the fins and scales and their original light grey color is preserved so perfectly as to resemble a fish just taken out of the water. Some of the specimens appear contorted; in others the form of the fish is wholly lost, the fins and scales and bones, being scattered about promiscuously, as if the fish had perished in violent struggles, or the rock had been disturbed after its imprisonment. Yet, in the same specimen that contains one thus mutilated, another will appear not more than a foot distant which is whole. I have found four or five specimens in which the fishes (both of them distinct,) lie across each other; sometimes a very thin layer of shale, and sometimes none, separating them. I have another specimen, three feet long and fifteen inches wide, containing seven distinct impressions. The shale in which these ichthyolites occur, when rubbed or held in a flame, exhales a strong bituminous odour.*

Among the impressions hitherto obtained, I can easily discover three distinct species that have scales.* Two of these are represented on the accompanying plate; but the third was so much mutilated, that I did not attempt to delineate it. For at the best it is no easy matter to represent them so exactly as to be of use. They are usually a little indistinct on their border, and not unfrequently injured by pyrites.

Fig. 1. represents a species that is rare.

Fig. 2. shows the most common species. There can be no doubt that this differs generically from the last.

*Precisely such a smell is exhaled from the bituminous limestone in Southington.

*See the end.

Fig. 3. is probably the same as Fig. 2.; but perhaps not. The outline is given because the fins were more distinct than in the specimen from which Fig. 2. was copied.

These are all of the natural size. Concerning their names, feeling altogether incompetent, I do not even attempt to decide. I have not had an apportunity to compare them closely with the Westfield icthyolites, and do not know whether they coincide.

Another petrifaction occurs with these fishes, which resembles the common silver eel, *(Muraena anguilla,)* or some other species of the eel tribe. The width varies from half an inch to a whole one, and the length from one to two feet. The substance of the eel (if indeed it be one,) is not converted into coal, but there is a substitution of the shale of a finer grain, except the head, which is coal. No fins appear, except, perhaps, in one instance, a pectoral one. Sometimes, along the centre of the impression, there is a small relief, answering to the place of vertebrae. The course of the impressions is usually serpentine.

The geological situation of these icthyolites is interesting. The shale containing them passes under Mount Toby, there being a gradual ascent from this spot to the top of the mountain, two miles distant: so that they lie beneath rocks of the coal formation at the depth of nearly nine hundred feet, most of the varieties described on the profile annexed to the map here alternating with one another. The following sketch exhibits a section of the shale of Mount Toby, so far as the geest would admit of examination, on a line passing from the locality of the icthyolites to the highest point of the mountain. I do not suppose it perfectly accurate, but it is probably sufficiently so to answer the intended purpose, viz. to exhibit the situation of the ichthyolites. The numbers in a parenthesis refer to those on the profile that are synonymous. The dip of these strata rarely exceeds ten degrees, and is usually less.

No. 1. (No. 59.) *Very Coarse dark grey pudding-stone*, for an account of it see the reference to the profile, on plate No. 8. at the end.

No. 2. *Bituminous Shale.* This contains icthyolites—strata nearly horizontal—dip never exceeding five degrees. Thickness of the stratum, about ten feet.

No. 3. Same as No. 1. except sometimes alternating with

a pudding-stone, less coarse and more distinctly stratified. Thickness, between two and three hundred feet.

No. 4. (No. 9.) *Red fissile argillaceous sandstone slate*, ten feet in perpendicular thickness.

No. 5. Same as No. 1. Thickness ten feet—dip six degrees.

No. 6. Same as No. 4. Thickness four feet.

No. 7. Same as No. 1. except not so coarse, and more distinctly stratified, agreeing nearer with No. 43 of the profile. Thickness fifteen feet.

No. 8. Same as No. 4. two feet thick. Where this rock alternates with the pudding-stone the change is very striking.

No. 9. Same as No. 7. Thickness fifteen feet.

No. 10. Same as No. 4. five feet thick.

No. 11. Same as No. 7. twenty feet thick.

No. 12. Same as No. 4. graduating into the conglomerate—ten feet thick.

No. 13. Like No. 1. sixty feet thick.

No. 14. *Grey argillaceous sandstone slate*, sometimes micaceous. Somewhat like No. 23. of the profile, but coarser—liable to decomposition and containing many water-worn pebbles. Thickness ten feet. This carries us to the Sunderland cave.

No. 15. Same as No. 4. fifteen feet thick.

No. 16. Same as No. 1. about one hundred feet thick.

No. 17. Same as No. 4. except that it is coarser and the layers thicker—about ten feet thick.

No. 18. A pudding-stone not differing essentially from No. 1. but frequently of a reddish cast and more distinctly stratified. This continues with little interruption to the top of the mountain; though the soil hides it in most parts, and there may be other alternations which I did not observe.

2. *A Clam Shell?*

I found a specimen at the cave in Sunderland, imbedded in an argillaceous slate, which resembles the common river clam. There was a perfect substitution of siliceous matter. A single specimen only was found, which was forwarded to Mr. Brongniart, and he will be able doubtless to decide whether it is a petrifaction or a peculiar water-worn pebble.

3. *Vegetable Remains.*

These appear to be either the branches or roots of trees, or the relics of culmiferous plants, and therefore may be called *lignites* and *rhizolites*. They are usually converted into a thin vein of coal, similar to the fish. They are commonly broken into pieces from an inch to two feet long, in the manner represented in Fig. 4. Their width varies from a mere line to two inches. They are not jointed—found in abundance at the falls in Gill; also with the icthyolites at Sunderland. The rock in which they occur at both places is hardly bituminous shale; but a greyish micaceous sandstone. The longest specimen of rhizolite I have seen occurs on the road side, one half mile south of Newgate prison; being not less than seven or eight feet in length.

4. *Unknown Relic.*

This is represented as well as it could be in Fig. 5. It is difficult to give a perfect idea of the thing, because there is a relief or swelling along the middle. It sometimes resembles the *ament* of the chesnut, *(Castanea americana Mx.)* but still more the vertebrae of a fish. But in no ichthyolite I ever found, did I see any remains of the vertebrae, and it is not probable, therefore, that this belonged to a fish. It is rare—found with the icthyolites at Sunderland.

15. Alluvion.

Colored Gamboge Yellow.

By this term I understand those accumulations of gravel, clay, sand, mud and salt, which are post-diluvian, or have probably been deposited since the Noachic deluge by causes at present acting on the globe. Some varieties may be seen along the Connecticut which we shall mention in the probable order in which they were deposited.

1. *The alluvion on the sea-coast.* This is probably the oldest; because the sea would begin its depositions immediately after the deluge, if the situation of any particular place were favorable—even before it had subsided suffi-

ciently for rivers to have found their channels. On the map it embraces the alluvial plain around New-Haven and the salt marshes extending some distance on both sides of the city. The plain of New-Haven is made up of coarse sand with some gravel and an intermixture of broken shells and sea weed. The marshes consist of sand, mud and salt.

The region about New-Haven, embraced by this alluvion, is interesting to the botanist, as he here finds many plants not growing in the interior. Among these, we may mention *Salsola kali*, *Salicornia herbacea*, *Triglochin maritimum*, *Statice limonium*, *Iva frutescens* of Lin. and *Ammi capillaceum* and *Conyza camphorata* of Muhl. *Limnetis polystachia* and *juncea* of Ph. *L. glabra*, Muhl. *Holcus odoratus*, Mx. and *Limosella subulata*, Ives. Here also, occur the other new species of Prof. Ives, *Gnaphalium decurrens* and *Asclepias lanceolata*, along with *Plantago maritima*, *lanceolata*, and *Virginica* of Lin. *Eriocaulon pellucidum*, Mx. *Cassia chamaecrista* and *Uniola spicata* of Lin. &c. &c. On the beach we find *Fucus nodosus* and *vesiculosus* of Lin.* and adhering to the latter, *Mytilus striatulus?* (Donov. in Rees.) Here also occur *Venus mercenaria*, (common clam) *Ostrea edulis?* (oyster) and one or two species of *Arca* and *Anomia*, with others I do not know.

2. *Gravel.* This usually lies beneath all other alluvial deposits along the Connecticut: though it sometimes alternates with beds of sand. It is arranged in somewhat regular strata. The pebbles rarely exceed two or three inches in diameter.

3. *Clay.* This is a coarse kind, such as is used for making brick; and generally lies above the gravel and beneath the sand and mud, or loam. It probably underlies those extensive sandy plains that occur in Suffield and Windsor, on the West, and in Springfield, Longmeadow, Enfield, East Windsor, and East Hartford, on the east of the Connecticut. In some places the clay appears at the surface, as in Hartford, Windsor, Deerfield, &c.

* On Long-Island, fifty miles east of New-Haven harbor, I found *Sphaerococcus confervoides*, Agardh.

4. *Sand.* This commonly lies the highest of the alluvion, except in some low meadows that are yearly receiving a deposite of a loamy sediment. The region in which sand occurs most abundantly, has just been mentioned. It is sometimes seen in alternating beds with gravel, clay and loam.

5. *Loam* and *mud.* This is the most recent of our alluvion, and depositions of it are frequently made. The Connecticut indeed, seems, with some exceptions, to have nearly reached its maximum of depositions, rarely flowing over more than a small part of the alluvion along its banks. But its tributaries, such as the Farmington, Westfield, Deerfield, and Chickapee, still continue annually, and often semi-annually, to flood the adjacent meadows, and to leave there an additional soil, from half an inch to six inches deep, and though the agriculturalist has sometimes to lament the destruction of his crops by these inundations, yet without them his fields would soon become comparatively unproductive.

The depth of the alluvion along the Connecticut has never been accurately measured; but I should judge it sometimes to be as great as one hundred and fifty feet; but in general it is much less. It is not unfrequent to find ten or fifteen feet below the surface of the most recent of this alluvion, logs, stumps of trees, leaves, butternuts, walnuts, &c. in a partially decaying state, and sometimes we meet with skeletons of the aborigines of the country. But no aurock, mastodon, or megatherium, has yet been discovered to give an interest to this alluvial formation.

I have found a difficulty in some instances in drawing the line between genuine post-deluvian depositions and geest. In some cases there appears to be a mixture. In other cases the rocks are entirely hid by the soil, and yet the predominant characteristic of the soil is derived from the rock underneath it, although there is a mixture of alluvion. The old red sandstone for instance, and the red slate of the coal formation, are very liable to decomposition, and thus a reddish soil is produced, so manifestly composed of the ruins of the rock, that one is able often to determine from the appearance of the soil at the distance of two or three miles the particular rock that lies beneath it. I have not,

however, intended to put down the alluvion in all such cases, but have colored the spot according to the subjacent rock. And on this ground I am sensible that there are a number of small parts of the alluvion that ought, in strictness, to have been colored as old red sandstone ; as in East-Hampton and Deerfield ; but being so small they were neglected.

16. Geest. *Jameson.*

Déluvian Detritus. Buckland.

"By geest," says Jameson, "is understood the alluvial matter which is spread over the surface both of the hilly and low country and appears to have been formed the last time the waters of the ocean stood over the surface of the earth." And it is probable that Professor Buckland refers to the same deposition by the above synonym. By deluvian detritus, he means "fragments of neighboring and distant rocks, and with bones not mineralized—generally in valleys." Whatever objections may lie against these definitions, every geologist knows that much deposition exists on the globe which no one refers to what is commonly understood by alluvion, and which could result from no processes nature is now carrying on. This is scattered over the most mountainous tracts, and in all cases of considerable extent, occupies at least three quarters of the surface. It is usually denominated soil, comprehending, however, the bowlder stones and organic remains that soil contains. As a general fact, this geest, in primitive regions, consists of comminuted particles and rolled stones of primitive rocks. In secondary tracts it consists of secondary detritus, though more frequently mixed with portions of rocks of a primitive character.

Along the Connecticut in the primitive region, large bowlders in great numbers are not commonly found removed many miles from the spot where they originated. Stragglers of this description may indeed be found almost every where ; and among all the rocks none seems to be more scattered than granite : though perhaps the numerous beds and veins of this rock found almost every where may ac-

count for this. But in general along this river, the character of the rolled masses corresponds to the rock in place underneath them ;—that is the greatest number of the loose stones are of the same description as the rock that underlies them. But to this there are many exceptions—a most remarkable one occurs a few miles west of New-Haven in Woodbridge and Milford. The surface is covered with rolled masses, sometimes quite large, of primitive and secondary greenstone, mica slate, gneiss, granite, and almost every other rock, except that which is in place viz. chlorite slate, or argillite. In many places on the map which are highly mountainous, the geest is so abundant as to occupy most of the surface ;—the subjacent rock rarely appearing ;—as in the east part of Plainfield and in Shutesbury. The diameter of the loose fragments varies from an inch to twenty, or even thirty feet, and they are usually rounded, indicating attrition. Some of the largest of these bowlders are found insulated on the pinnacles of our mountains.

There is a particular kind of geest, which I have already mentioned, occurring along the Connecticut, that does not seem to be comprehended in Professor Jameson's definitions. It is that kind of soil that results from the slow disintegration and decomposition of certain rocks, with a mixture of decaying vegetables. This, as already observed, is not uncommon above the old red sandstone and the red siliceous sandstone slate of the coal formation. And the epithet *deluvian* seems to exclude this kind of soil from Prof. Buckland's *deluvian detritus;* and so the epithet *fluviatile* excludes it from the *fluviatile detritus* of the same author. (Rees' Cyc. Art. Geology, Addenda.)

Hayden's Hypothesis of a primeval northeasterly current of water.

I allude to Hayden's Geological Essays, in which he expresses the opinion that the alluvion of our middle and southern states was formed by a current or currents that formerly flowed across this continent from the northeast to the southwest; and I am inclined to believe, (without intending, however, to adopt altogether his theory on the

subject,) that a careful examination of the bowlder stones along the Connecticut would favor the supposition. Masses of greenstone are found at a greater distance, and in much greater quantities on the western side of the ridges than on the eastern. As we ascend the primitive region on the west side of the river, secondary rolled stones are seen for one or two miles; but on the eastern side, if I mistake not, nothing of this kind appears; and I should suppose the bowlders of Woodbridge and Milford, being evidently brought from the country to the north, would testify in favor of such an hypothesis.

Suggestion concerning rolled Stones.

Is it not a fact that rolled masses are more abundant and more perfectly rounded along the limits between the primitive, and transition, or secondary? This question has often occurred to me when travelling in the south eastern part of Massachusetts, when going over the country along the Connecticut in Bernardston and its vicinity, when descending the Hoosack and Green Mountains on the west, and when passing over the country west of New-Haven. If such be the fact it may, when it occurs in the geologist's tours, be a warning to him to expect a change in the rocks in place.

Fact relating to the detachment of large bowlder stones from their bed.

Deerfield river in the greater part of its course is a mountain torrent, very rapid and powerful. It has worn a passage often four hundred feet deep, the banks being almost perpendicular. Its winter floods are most powerful in effecting this work. The ice freezes three or four feet thick, and when a sudden rain melts the snows on its banks, it rises rapidly and lifts up and urges forward with tumultuous fury, this immense body of ice. As the banks among the mountains are steep and rocky, they prevent the accumulation of water and ice from spreading to the right or left, and it is raised proportionally higher; and thus an immense force is exerted upon obstacles in the bottom of the

stream, which, in winter floods, is filled with huge masses of ice to the very bottom.

In the west part of Shelburne this river descends a cataract thirty or forty feet high. The rock in the bottom of the river is an aggregate of quartz and mica with hornblende intermixed, and below the falls it is unstratified, almost without seams and very hard. Yet here we might expect the force of the torrent would be most powerful; and accordingly we find masses of this rock from one to ten feet in diameter, raised from their bed, and some of them removed down the stream one or two miles, some only a few rods, and I saw one or two of the largest but just beginning to be raised from their bed. Previous to viewing this spot, I had no just ideas of the enormous force exerted by a mountain torrent.

GEOLOGY, MINERALOGY, TOPOGRAPHY, &c.

OF THE CONNECTICUT.

PART II.

Simple Minerals.

Metallick Veins and Beds.

Before giving a list of the simple minerals found along the Connecticut, it may perhaps be acceptable to the geologist, to present a short account of those veins and beds of ore, that occur in the district, which either have been, or may be wrought as mines.

1. *Southampton Lead Mine.**

This is a vein containing sulphuret, carbonate, sulphate, molybdate, muriate and phosphate of lead, with blende, pyritous copper, &c. The gangue is quartz, with sulphate

* For a description of this mine, by Professor Silliman, who examined it in May 1810, see Bruce's Journal, Vol 1. p. 63.

of barytes and fluor spar intermixed. The vein declines ten or fifteen degrees from a perpendicular; is six or eight feet in diameter, and traverses granite and other primitive rocks. It has been observed at intervals from Montgomery to Hatfield, a distance of twenty miles: but it is very doubtful, whether it continues, uninterruptedly, the whole of that extent; indeed, from what I have observed of other lead veins in the vicinity. I have sometimes been disposed to question, whether the veins observed at many of these intervals, may not be totally distinct from one another. In Southampton, eight miles south west from Northampton, is the only spot where this vein has been extensively wrought. In that place it has been explored thirty or forty rods in length, to the depth of forty or fifty feet, and the galena, which is the principal ore, has been found in masses from a quarter of an inch, to a foot in diameter. At the depth above mentioned, the water became so abundant, that it was thought advisable to abandon a perpendicular exploration, and to descend to the foot of a hill on the east, nearly eighty rods from the vein, and attempt a horizontal drift, or adit, and ever since its commencement, seven or eight years ago, the working of the vein has ceased. This drift is now carried into the hill, on an exact level, nearly sixty rods, and the workmen told me, that not less than 20,000 dollars had been expended upon it. The rocks that have been penetrated, reckoning from the mouth of the drift inwards, are geest, the red and gray slates of the coal formation, ("granulated schistose aggregate." *Eaton.* Journal of Sci. Vol. I. p. 136,) with thin beds of coal, and mica slate, and granite alternating. Probably the fundamental deposit of granite is now uncovered; and the principal vein of galena cannot be far distant. Several small branch veins of crystallized quartz and galena have been crossed; and several specimens of these, collected by Dr. Hunt, were very rich and beautiful; the crystals of pure galena sometimes exhibit, on their faces, insulated crystals of honey coloured carbonate of lime. The principal vein will be found not less, I should judge, than one hundred and fifty feet below the surface:—and when that time comes, it is confidently expected, not only that the proprietors will be rewarded for the great expence they have incurred, but, also, that many a rich specimen will be found to ornament the

mineral cabinets of our country, and to vie in beauty with the lead ores of Europe.

The mouth of this drift is four or five feet wide, and about three feet above the surface of the water. The water is deep enough, the whole length of it, to admit the passage of a loaded boat. The person wishing to explore this internal canal, must fire a gun at the entrance, or beat heavily with a sledge on the timbers that support the soil; in ten or fifteen minutes he will perceive a gentle undulation of the water, and soon after a boat advancing with lighted lamps and a rower; having seated himself on the bottom of this boat, and provided himself with an additional garment, he is prepared for his subterranean expedition. As he enters the passage, he will, for a moment, experience, or imagine he experiences, a little difficulty of breathing. But he will soon become reconciled to his condition; and after passing about one hundred feet in the excavation, for which distance the soil is supported by timbers, he will find occasionally more room, so that he can stand erect. If he looks back, after having advanced several hundred feet, the light at the entrance will appear diminished to the size of a candle; and before he reaches the extremity, it becomes invisible. About half way from the entrance to the end of the drift, he will pass a shaft; down which a small brook is turned, for the purpose of aiding the ventilator. When he reaches the end of the drift, he finds himself to have penetrated nearly sixty rods chiefly into solid rock; a voyage which although inferior to that performed in the celebrated navigation mine, in the Peak of Derbyshire, is still extremely interesting.

The miners do not quit the drift when they blast; but retire behind a breast work thrown up for the purpose. Entering immediately after an explosion, I did not perceive the air to be in any degree more oppressive than when powder is fired above ground. One man told me that he had been an inmate of that dark recess, eight or ten years, without suffering in his health, and when he returned alone into his dreary prison after conducting me to the day light, he struck up a cheerful song, indicating buoyant spirits and a contented mind.

Every mineralogist passing that way, will of course visit this drift. Intelligent gentlemen without professional views,

and even ladies not unfrequently enter this cavity, and find themselves amply repaid for their trouble.*

2. *Vein of Galena in Whately.*

This occurs in the north west part of the town, and I formerly supposed it a continuation of the Southampton vein. But the Southampton vein runs north east and south west, and this in Whately almost exactly north and south. Besides, the Southampton vein must turn almost at right angles from Hatfield, in order to be found in the north west part of Whately.

This vein may be traced at intervals one hundred rods, and extends into the edge of Conway. At the extremities it traverses mica slate; but in the middle, it cuts through an extensive bed of granite. Its diameter is usually six or seven feet, and the gangue is wholly common and radiated quartz. Galena, which is the only ore found in this vein, is disseminated through this matrix in considerable abundance. Very few efforts have been made to explore this vein, though appearances at the surface are not unfavorable; and if a horizontal drift were necessary, a deep valley within a few rods on the west, would afford a favourable opportunity for making it. As nearly as I could determine, this vein is not far from perpendicular to the horizon.

3. *Vein of Galena in Leverett.*

In the south west part of the town—traversing granite—only a foot wide—gangue, sulphate of barytes—deviation north and south—galena the only ore.

4. *Vein of Galena, Pyritous Copper and Blende, in Leverett.*

About two miles north of the vein last mentioned; and it may be a continuation of it. The gangue is quartz, united with sulphate of barytes; and the galena and pyritous copper are disseminated through it in nearly equal quantities.

* I have often thought Professor Cleaveland must have selected the appropriate motto prefixed to his Mineralogy, when entering this or some similar drift.

——————— itumest in viscera terrae &c.

The blende is much less abundant. The vein is several feet wide, traverses mica slate and granite, and has been considerably wrought.

5. Lead Mine at Middletown.

I am unacquanted with the geological situation of this mine. I put it down on the authority of Professor Silliman in Cleaveland's Mineralogy.

6. Vein of Galena at Bethlehem.

I mention this on the same authority without any personal knowledge of it. It is, however, a little beyond the limits of the map.

7. Vein of Galena and Pyritous Copper in Southington.

Same authority—gangue, sulphate of barytes and quartz. I believe this vein occurs in the coal formation.

8. Mine of Galena, Blende and Pyrites in Berlin.

This occurs in greenstone, at its junction with the coal formation. The gangue is sulphate of barytes. The galena crystals are small; those of the blende larger; the pyrites is the least abundant. The vein is not now wrought. (Vide Dr. Percival's Notice, Journal of Science, Vol. 5. p. 44.)

Copper Mines and Veins.

It has already been mentioned, in the geological part of this sketch, that these ores (like the mine of galena &c. last mentioned,) exist along the junction of the greenstone with the coal formation. The veins frequently pass into both rocks, and are of various sizes and of frequent occurrence. Indeed, they may be found probably every mile or two along the line, where these rocks unite. A few of them, that have obtained some notoriety will be mentioned.

9. *Vein of Pyritous Copper and Green Carbonate of Copper, at Cheshire.*

In greenstone and associated with sulphate of barytes, quartz, carbonate of lime and sandstone. (Silliman in Cleaveland's Mineralogy, Vol. 2, p. 559.)

10. *Mine of the Red Oxide of Copper, Green Carbonate of Copper, &c. Granby.*

This is better known by the name of Simsbury Mines although it occurs within the boundaries of Granby. It was formerly wrought, but being at length abandoned, its shafts and galleries were converted into a state's prison. The mineralogist who explores this spot, must here contemplate the painful spectacle of almost every variety of guilt and crime. Sixty or seventy whites, mulattoes and negroes, scarcely distinguishable through filth, from one another, are here compelled by the point of the bayonet to labour at the anvil; while we read in their sullen and ghastly countenances, the inward workings of hearts rendered desperate by crime and punishment. As we descend into the shaft we observe the offensive recesses in the rocks, where these prisoners were formerly confined during the night. But only a few of the most refractory are now compelled to sleep in these damp and dismal dungeons; the government of Connecticut being satisfied that this kind of rigor served rather to harden than to reform the criminal. About seventy feet below the surface, the conductor pointed out to me a bolt driven into a wet rock, where, recently, one of the prisoners had been fastened for a week or fortnight, as an extra punishment for peculiar obstinacy; and where he lay, I saw scattered, the leaves of a bible, which, in his desperation he had torn in pieces:—thus spurning alike the laws of God and man!

If we judge from the present appearance of this excavation the original vein of ore must have been extremely irregular, forming *bellies* and *twitches*. It passes through the greenstone and enters the red and gray micaceous sandstone of the coal formation, which underlies the greenstone. All the varieties of ore I saw at the place were the red ox-

ide disseminated in sandstone, and mixed with a small proportion of green carbonate of copper. How productive this mine has been, I do not know.

11. *Vein of Green Carbonate of Copper and Pyritous Copper in Greenfield Mass.*

This is found on the west bank of Connecticut River, one hundred rods below the mouth of Fall river, and about the same distance in a direct line from Turner's Falls. It occurs at the junction of the greenstone and red slate of the coal formation, and passes obliquely into the hill of greenstone on the one side, and into the slate on the other in the bed of the river. The principal vein is five or six feet in diameter, and the matrix, toadstone, which is traversed, in the direction of the vein, by several veins of sulphate of barytes, which form *saalbandes*. The principal ore that appears at the surface is the green carbonate, the pyritous copper being rarer.

12. *A similar vein in the same township.*

About a mile below the vein just described, (down the stream,) is another, which I am told is very similar and therefore needs no description. In other places between these veins, I have noticed, in the red slate, veins of the green carbonate of copper, not more than a quarter of an inch thick, while the walls are glazed so as to resemble polished steel; constituting handsome specimens of the *Slickenside* of the Germans.

Mines, Veins, and Beds of Iron Ore.

13. *Micaceous Iron Ore in Veins, in Montague.*

Near the north line of the town, a little south west of the mouth of Miller's river, a granitic hill of considerable extent and elevation is traversed by veins of this ore in all directions; constituting one vast *stock werke*. The principal vein is nearly ten feet in diameter, and the gangue is quartz. I do not see why this ore could not be profitably wrought. See Journal of Science, Vol. 1, p. 438, where this ore is described under the general name of specular oxide of iron.

14. *Mine of Magnetic and Micaceous Oxide of Iron, in Hawley.*

This exists in the north western part of the town, in beds, in talcose slate. The folia of the slate are nearly perpendicular to the horizon, and the principal bed of the ore varies from six inches to three or four feet in thickness, and numerous thin beds occur at the sides. The mine has been opened twenty or thirty rods long, and thirty or forty deep. The magnetic oxide is probably most abundant: but the micaceous oxide has not till lately been wrought, through an impression that it could not be smelted! One or two tons of it lie beside the mine ready for the mineralogist. I have never seen any ore of this sort, that will bear any comparison for beauty and richness of appearance with this. It has a schistose, gently undulating structure, and plates of it may be easily obtained, a foot in diameter, possessing a highly glistening aspect. But it is no very easy matter to get at this mine, on account of the extreme roughness of the country for several miles around it.

15. *Mine of Magnetic and Micaceous Oxide of Iron, in Bernardston.*

This occurs in beds in talco-argillite, and is so similar to the last described, that additional remarks are unnecessary. I do not know to what extent it has been wrought.

16. *Vein of Micaceous Oxide of Iron, in Jamaica in Vermont.*

This exists in dolomite, and is very beautiful. It has been used as a substitute for smalt, and answers well. I do not know its extent. It is a few miles beyond the northern limits of the map.

17. *Mine of the Brown Oxide of Iron, in Salisbury in Connecticut.*

This, as well as the two following mines, occurs a considerable distance beyond the limits of the map. I merely mention them, however, because of their interesting nature; and

In giving a list of the simple minerals, I do not intend to be scrupulously confined to the region embraced by the map. This mine is wrought in a bed in clay. For further particulars see Prof. Silliman's account of this ore, in the Journal of Science, Vol. II. p. 212.

18. *Mine of the same ore, in Kent, in Connecticut.*

This is found, like the last, in a bed in clay. See Vol. II. of the Journal of Science, p. 216.

19. *Mine of Carbonate of Iron, in New-Milford, in Connecticut.*

This exists in a vein, in gneiss; and its gangue is quartz. See Journal of Science, Vol. II. p. 226.

20. *Bed of Bog Iron-Ore, in New-Braintree, in Massachusetts.*

This ore is not uncommon along the Connecticut; but I have never examined a bed of it, except in New-Braintree, in Massachusetts. It lies in a valley, in a country of gneiss, only a few feet below the surface; and has been explored to a considerable extent.

21. *Mine of Arsenical Cobalt, in Chatham, in Connecticut.*

It exists in a bed, in mica slate, varying in width from a few inches to a few feet. The matrix is a mixture of hornblende and actynolite, in which the ore is disseminated. It was explored several years since, and has been again opened recently; the undertaking is now, however, abandoned. Arsenical sulphuret of iron, arsenical nickel, and arseniate of cobalt are found in this mine in small quantities.

22. *Mine of Bismuth, Silver, Argentiferous and Common Galena, Blende, Tungsten, Tellurium, Magnetical and Common Pyrites, Spathic Iron, Native Sulphur, Pyritous Copper, &c. in Huntington, in Connecticut.*

The various minerals mentioned above, have been found in a vein traversing gneiss, although it has yet been explored only a few feet in depth. The gangue is quartz. For a more particular description of this interesting spot, see various articles by Professor Silliman, in the first five volumes of the Journal of Science.

In the above enumeration several small and unimportant veins of ore have been omitted; and probably many important ones are yet undiscovered. In some instances I have met with men who profess to have found beds or veins of ore, but will not disclose the spot, because they intend to render themselves independent by their discoveries. Indeed, were the mineralogist to pay attention to all he will hear on this subject in his travels, he would be led to suppose that every town, and even every farm, is a rich repository of metals. For he will often be told, how in such a mountain the aborigines used to obtain iron, lead or silver; or how, in such a place, the lightning frequently strikes, as a certain indication of metallic ores; or how in such a place *the mineral rod will work;* and a thousand such mummeries, by which honest but credulous men are frequently deluded, and sometimes ruined.

List of Simple Minerals found along the Connecticut.

I have already remarked, that in giving this list, I should not be confined precisely to the limits of the map; but where an interesting mineral has been found a few miles beyond these, I shall notice it. I shall annex to each species and variety, merely the localities and name of the discoverer, except in cases where I am able to add some particulars not heretofore published. To save all further trouble of reference, I have taken the second edition of Cleaveland's Mineralogy as a standard for names and arrangement. And, indeed, I feel as if a better disposition of minerals could scarcely be made, in the present state of the science, than that excellent work presents.

The species and sub-species are numbered in order from first to last. The varieties also, whenever they occur, are usually numbered.

1. *Nitrate of Potash.* Effloresing on the soil under old buildings, &c.

2. *Sulphate of Barytes.* At Cheshire, Southington. Farmington, New-Stratford, and two miles from Hartford. (*Silliman.*) Also at Berlin. (*Percival.*) Also at Hatfield. (*Gorham.*) Also at Middlefield. (*Eaton.*) Also at Southampton lead-mine, at the Leverett lead veins, and at the Greenfield copper veins. At the three last mentioned places it is chiefly the lamellar variety.

3. *Calcareous Spar.*

1. *Crystallized.* At the Marble Quarry in Milford, in rhombic crystals; also in the lead mine at Middletown. (*Silliman.*) Also at the lead mine in Southampton, in limpid and straw-colored crystals on galena and quartz. Forms of the crystals. 1. A dodecaedron, composed of two six-sided pyramids, applied base to base. (*hog-tooth spar.*). 2. A short six-sided prism, terminated by three-sided pyramids. 3. The same, with all the solid angles of the prism truncated; forming a crystal of twenty-four faces. Also, in greenstone in Deerfield and Greenfield; and in a coarse limestone in Leyden, Conway, &c. in rhombs.

2. *Laminated.* At Milford Hills. (*Silliman.*) Also, in veins in greenstone, Deerfield.

4. *Granular Limestone.* At Milford Hill, embracing the bed of Verd Antique Marble. (*Silliman.*) In Wilmington, Vt.?

5. *Concreted Carbonate of Lime.*

1. *Calcareous Incrustations.* In the Coal Formation in Sunderland, &c.

6. *Argentine.* At Washington, Litchfield Co. (*Brace.*)

7. *Magnesian Carbonate of Lime.*

1. *Crystalyzed.* (Rhomb Spar.) Near New-Haven, with abestus in Serpentine. (*Silliman.*) Abundant at the Milford Marble Quarry. Also at Middlefield, in Soapstone. (*Dewey.*) Also at Southampton lead mine. (*Eaton.*)

2. *Dolomite.* At Washington and Milford Hills. (*Silliman.*) Also at Litchfield. (*Brace.*) Also at Middlefield. (*Dewey.*) Also at Jamaica, in Vermont. (*J. A. Allen.*)

8. *Brown Spar.* At Leverett, in a vein of galena, pyrites, copper and blende, grouped in rhombic crystals on quartz; the lamellae usually curved.

9. *Fetid Carbonate of Lime.* At Northford. (*Silliman.*)

10. *Bituminous Carbonate of Lime.* Near Middletown, with Ichthyolites. (*Silliman.*) Also at Southington, in the Coal Formation.

11. *Phosphate of Lime.*

1. *Apatite.* At Milford Hills. (*Silliman.*)

12. *Fluate of Lime.* Cubic and massive fluor spar occurs in Huntington—also chlorophane in the same place. (*Silliman.*) Also at Middletown, in the lead, &c. vein. (*Brace.*) Also at Southampton lead mine, green and purple. (*Gibbs.*) Also at Deerfield, crystallized in dodecaedrons? purple—in a loose stone, which contained also a crystal of galena. (*Cooley.*) Also at Putney, massive and grass green, forming a vein in bastard mica slate. (*Silliman.*) Also at Westmoreland, light green. (*Hall.*) Also at Conway, massive, light green, in small quantities in a vein in mica slate.

13. *Gypsum.* In amygdaloidal greenstone in Deerfield, in small quantities; "crystallized—white, and retaining its water of crystallization." Found by Dr. Cooley, and determined by Professor Silliman. This has been already mentioned in the geological part of this sketch.

14. *Sulphate of Alumine and Potash.* (Alum.) In Leyden, efflorescing on bastard argillite. Also in Conway, on mica slate.

15. *Common Quartz.*

1. *Limpid Quartz.* At Grafton in Vermont, remarkably pure. (*Hall.*) Also at Plainfield. (*J. Porter.*) Also in the veins of lead, &c. at Southampton and Leverett, and the copper veins in Greenfield, in six-sided prisms. At the latter place it occurs with both the terminations perfect. Also in veins in sienitic granite, at Northampton. Also in geodes in greenstone at New-Haven, Berlin and Deerfield. Also in veins and geodes from one to ten inches diameter, in mica slate in Conway. The crystals are of every size from one tenth of an inch to two inches diameter, and occur in vast quantities. In the same town fragments of crystals occur, as transparent as the quartz from Madagascar.

2. *Smoky Quartz.* At Torrington and Cornwall. (*Brace.*) Also at Plainfield and Brattleborough? amorphous.

3. *Yellow Quartz.* In crystals at the Southampton lead mine; of a honey yellow, resembling the Siberian topaz. The coloring matter appears to penetrate the crystals. Also in small quantities at the lead mine in Leverett.

4. *Rose-Red Quartz.* At Southbury, very abundant. (*Silliman.*) Also at Chatham and East-Haddam. (*T. D. Porter.*) Also at Deerfield; a single specimen in alluvial soil.

5. *Irised Quartz.* At Plainfield. (J. Porter.) Also at Leyden, in mica slate.

6. *Milky Quartz.* At Litchfield. (*Brace.*) Also at Cummington and Plainfield. (*J. Porter.*) The specimens that I have seen of this variety (and they are scattered abundantly over the mica slate region west of Connecticut river,) are rather poorly characterized, seeming to be intermediate between limpid and milky quartz.

7. *Radiated Quartz.* In the Southampton, Whately and Leverett veins of galena; in abundance. Also in Conway, in veins and loose masses.

8. *Tabular Quartz.* In greenstone, Deerfield—Lamellae usually applied to one another by their broader faces, and separating as thin as mica, but very brittle. Sometimes they intersect and produce cells of various forms. Also in Conway, in large loose masses among mica slate. Pieces more than a foot in diameter have been noticed, having both the structures above mentioned. The plates forming the cells are sometimes covered on their broader faces with minute quartz crystals. In some specimens there is a gradation from tabular to common amorphous quartz; the folia becoming less and less distinct, and finally disappearing.

9. *Granular Quartz.* At Vernon, Vermont, forming a bed in argillite. (*J. A. Allen.*)

10. *Pseudomorphous Quartz.* At the Southampton lead mine and in Deerfield greenstone—the impressions being cubical. At the latter locality also, a very curious variety of this mineral occurs. The quartz is the common limpid kind; passing, however, in some parts, into chalcedony; and it contains numerous cavities that diverge from a centre. Their form is that of a four-sided, nearly rectangular prism, generally a little flattened, and, of course, lessening to a point at one end. Their length is from half an inch to four inches. A complete sphere is seldom filled by them; usually not more than a quarter part of it; and at their outer extremity they are so scattered as not to fill half the surface of the sphere. I have sometimes observed these cavities proceeding from different centres, crossing one another. Although it is no uncommon thing to meet with these cavities, yet I have never found any mineral occupying them. An interesting question then occurs; by what were they once occupied? The probability is, that it was some variety of zeolite. Yet no zeolite of this description has been found in the greenstone in the vicinity. It exists in balls perfectly filled; the crystals usually circular, and the concretion never much larger than a musket ball. But the zeolite, it is well known, does occur in radiated masses several

inches in diameter, the outer extremity of which presents the form of the prism. I am rather disposed to believe that these cavities were once filled by a mineral not differing much from the Thomsonite of Dumbarton in Scotland.

Some varieties of quartz occur along the primitive region of the Connecticut that can hardly be referred to any of the preceding. Thus, there is a variety very abundant in beds and tuberculous masses in mica slate and argillite, which differs in nothing from limpid quartz, except that it is colored crimson red; and perhaps it ought to be referred to ferruginous quartz; but it differs from that commonly so called. Another variety is abundant every where, in large rolled masses, of a reddish grey color when broken, with a chonchoidal uneven fracture—the structure being almost granular, and the aspect considerably like hornstone. Another variety, more rare, occurring in pudding stone, is of a light blue color, and scarcely translucent; but it can hardly be called the *blue quartz* of mineralogists. Another variety is found in granite and in loose masses, and is nearly black, and only semi-transparent. Another variety has a tinge of yellow—another of green, &c.

16. *Amethyst.* At Wallingford, Farmington, Berlin and East-Haven. Also at Mount Tom in East-Hampton. (*Silliman.*) Also in greenstone, Deerfield, forming geodes of a light purple; crystals from one tenth of an inch to an inch in diameter. Also in Westminster, Vermont, in crystals an inch and an half in diameter.

17. *Ferruginous Quartz.* At Litchfield. (*Brace.*)

18. *Fetid Quartz.* I have recently found this in several places, from Woodbridge, near New-Haven, to Bellows-Falls in New-Hampshire, a distance of one hundred and fifty miles, in loose rolled masses. In the vicinity of Conway it is very abundant, and occurs crystallized in the common six-sided prisms; which are sometimes so flattened as to be three times as broad as thick. In Conway it occurs in veins in mica slate and granite; less fetid, however, than that which is found loose on the surface. It is traversed by thin seams, or veins, apparently ferruginous; its color is nearly milk white and its lustre a little resinous. In some specimens the fetid odour is very strong.

19. *Chalcedony.*

1. *Common Chalcedony.* At East-Haven, in greenstone. (*Silliman.*) Also in the same rock at Southington, Farmington, Hadley, Sunderland, Deerfield, Greenfield, Gill, and indeed, in almost every greenstone hillock and ridge from New-Haven to Gill. Its color is light grey, deep grey, brownish, yellowish and greenish grey; it occurs botryoidal, mammillary, cylindrical and reniform, and is often of a cloudy or milky appearance, and frequently, strongly translucent.

2. *Cacholong.* In greenstone, Deerfield. It is associated with common chalcedony, and frequently, envelopes it, or constitutes some of the bands of agates. Its color is milk or yellowish white.

3. *Carnelian.* In greenstone, Deerfield. United with common chalcedony and cacholong, into which it passes. Its color is usually pale or yellowish red. It is not abundant. Also at East-Haven.

4. *Sardonyx?* Some specimens of the carnelian in Deerfield greenstone, being reddish yellow and orange, appear to belong to this variety; but it occurs in so small quantities as hardly to be worth noticing.

Agate. This occurs at East-Haven and Deerfield; and as it is composed of varieties of chalcedony and quartz, this seems to be the proper place to notice it. A description of a part of the agates occurring in these localities has already been given with sufficient minuteness in the American Journal of Science, and in Cleaveland's Mineralogy. But since the publication of those accounts, Dr. Dennis Cooley has discovered a new locality in the Deerfield greenstone, from which he has obtained specimens so much superior to those heretofore found that they deserve a particular notice. The following is a description of specimens in his possession.

No. 1. Longer diameter of the face of the agate, nine inches—shorter diameter, six inches. Outer zone, greenish chalcedony, half an inch broad. Second zone chalcedony,

a little tinged with red, a quarter of an inch broad. The centre is occupied by an amethystine geode of a light purple. Weight of the whole agate, twenty-three pounds.

No. 2. Face seven inches by four—Outer band, one fourth of an inch wide, of yellowish red carnelian; second band greyish white chalcedony, one fourth of an inch. The remainder of the space is occupied by a geode of limpid quartz. The outer coat of carnelian is broken off from a large part of this specimen, leaving bare the whi ish chalcedony, and it has a strong resemblance to the human cranium; exhibiting similar protuberances and concavities.

No. 3. Face three inches in diameter—outer band of yellowish red carnelian—second do. chalcedony a little tinged with red, one tenth of an inch—third do. cacholong, one tenth of an inch—fourth do. light carnelian, one tenth of an inch. The centre is occupied by common quartz, not forming a geode.

No. 4. As it appears at one end: Diameter of the face three inches—outer zone three fourths of an inch thick, of yellowish green chalcedony—second do. carnelian, one fourth of an inch—third do. quartz, having a greasy aspect—fourth do. dark grey translucent chalcedony, a mere line in thickness—fifth do. quartz or milk colored chalcedony, one tenth of an inch—sixth do. dark grey chalcedony, a line broad—seventh do. quartz, one fiftieth of an inch—eight do. dark grey chalcedony, a line broad—ninth do. quartz, one tenth of an inch—tenth do. chalcedony, a line broad—elevenh do. quartz, one fiftieth of an inch—twelfth do. a line of chalcedony—thirteenth do. quartz, one thirtieth of an inch—fourteenth do. a line of chalcedony. The centre is occupied by limpid quartz. This is a *fortification agate*, and the parallelism of the several bands is most exactly preserved, and the angles are perfect. Viewed on a face at right angles to that above described, this specimen exhibits a *striped or ribband agate*.

No. 5. Made up of an almost countless number of darker and lighter colored bands of whiteand grey chalcedony—two or three small agates appearing on the same face

This appears to be a real *chalcedonyx;* and such specimens are not uncommon.

No. 6. *Fortification and Eyed Agates*, in the same specimen. One of the latter is an inch in diameter, and has six or seven zones of lighter and darker chalcedony and one of carnelian, enveloping a nucleus of light blue chalcedony.

These specimens seem to want nothing but a polish to make them equal to any in the splendid cabinet in New-Haven. The rock in which they occur is not strictly amygdaloidal, but contains only a few large cavities; and so firmly are the agates fastened into their bed that one is often obliged to break them out by piecemeal; thus ruining the most superb specimens. The larger ones are not very abundant. The rock, however, has not been penetrated very far.

20. *Siliceous Sinter.* At East-Haddam, in gneiss and incrusting mica slate. (*T. D. Porter and Webster.*)

21. *Opal.* "Common opal has been found in Litchfield, though rarely." (*Brace.*)

22. *Flint.* Near New-Haven and in Woodbridge, in rolled masses. (*Silliman.*)

23. *Hornstone.* At Litchfield. (*Brace.*) At the Southampton lead mine; also in Conway. Also in greenstone at Southington and Deerfield At the latter place it occurs in nodules often four or five inches in diameter. Its colors are grey, green, black with a tinge of red, and dark blue. Its fracture is sometimes a little chonchoidal and glistening, sometimes dull and splintery; and it is scarcely translucent at the edges. Some specimens considerably resemble siliceous slate, and others appear like prase. But Professors Silliman and Dewey (the latter of whom has examined it chemically,) agree in calling it hornstone. Also in Sunderland in greenstone, in narrow veins—well characterised.

24. *Jasper.* Near New-Haven in rolled masses. (*Gibbs.*) Also at Cummington on the banks of Westfield river. (*J. Porter.*) Also on the banks of Deerfield river in Deerfield,

and in Conway, Leyden, &c. in rolled fragments, red, black and yellow.

25. *Corundum.* At Litchfield, massive and in six-sided prisms, imbedded in massive sappar. (*Brace.*)

26. *Cyanite.* At Litchfield, Harwinton, Watertown and near New-Haven. (*Silliman.*) At the former place a mass of this mineral, associated with talc, sulphuret of iron and corundum, is supposed to weigh one thousand five hundred pounds. (*Brace.*) Also at Middle-Haddam. (*Eaton.*) Also at Chesterfield, Mass. in loose masses in mica slate; where its bladed or imperfect prisms are two feet long. (*Hunt.*) Also at Granville. (*Dewey.*) Also at Plainfield. (*J. Porter.*) Also at Grafton, Vermont, and Charlestown, New-Hampshire. (*Hall.*) Also at Bellows Falls. (*Silliman.*) Also at Deerfield, in mica slate. (*Williams.*)

27. *Staurotide.* At Bolton, East-Hartford, Beacon-Hill, Litchfield, Harwinton and Chatham. (*Silliman, Brace, Eaton and Woodbridge.*) Also at Cummington. (*J. Porter.*) Also at Bellows Falls. (*Hall.*) The range of mica slate in which this mineral is found in Bolton, Chatham, &c. extends, with little interruption, into New-Hampshire and Vermont, at least as far as Bellows Falls; and its aspect is very similar throughout, and scarcely a mile of the distance is it wanting in staurotide; or rather, wherever I have crossed it, (in perhaps fifty places) this mineral occurs; as in Vernon, where it is in vast quantities, in North-Wilbraham, Ludlow, Shutesbury, Leverett, Northford, Hinsdale, Chesterfield, Putney, Westminster, &c. In Chesterfield, New-Hampshire, Dr. J. A. Allen found crystals an inch and one fourth in diameter, and two inches and an half long, in the valley south-west of the meeting-house. A range of similar mica slate extends through Chesterfield, Mass. into Cummington, Plainfield, Hawley, &c. and here also staurotide occurs in abundance. In Chesterfield I noticed a mica slate rock, two or three feet thick, containing seven or eight distinct *layers* of this mineral.

28. *Pinite.* At Haddam, in mica slate and granite. (*Silliman and Webster.*) Also at Bellows Falls. (*Hall.*)

29. *Chrysoberyl.* At Haddam, on both sides of the river, in six-sided prisms and six-sided tables, in granite. (*Gibbs.*)

30. *Zircon.* At Sharon, Litchfield county, in quartz. (*Silliman.*) Also at Brimfield, in gneiss. (*Eaton.*)

31. *Siliceous Slate.*

1. *Basanite.* Sometimes found in alluvial soil on the banks of Deerfield river; but perhaps brought thither by the aborigines, who made use of this and of jasper for barbs to their arrows and pikes.

32. *Pitchstone.* Near New-Haven. (*Silliman.*)

33. *Mica.*

1. *Laminated.* At Leverett, Alstead, &c.

2. *Lamellar.* At Woodbury it is violet. (*Silliman.*) Also at Goshen, Mass. yellowish green and violet, and sometimes in rhombic tables. (*Gibbs.*) Of the same colors at Bellows Falls, in granitic veins. (*Silliman.*) Most of the mica in the granitic veins in Conway, Ashfield, Williamsburgh, Chesterfield, &c. is straw yellow, sometimes rose-red, and in these veins it exists in excess. It occurs in these and other towns also, in granite of a smoky or nearly black color.

3. *Prismatic Mica.* Near Watertown. (*Silliman.*) At Litchfield. (*Brace.*)

34. *Shorl.*

1. *Common Shorl.* At Haddam, in six-sided prisms, terminated by three-sided pyramids. (*Gibbs and Webster.*) It occurs in almost every town in the primitive region along the Connecticut. Localities where it is found abundant, or beautiful, are Pelham, Shutesbury, Orange and Brattleborough. At the latter place it is found abundantly near the centre of the town in mica slate or hornblende slate: and also near the north line of the town (mentioned in Cleaveland's Mineralogy as occurring in Dummerston,) it

exists in crystals half an inch in diameter and often four or five inches long, sometimes terminated by three-sided pyramids, in common white quartz. The contrast renders the specimens quite beautiful, and one large loose mass lies on the surface nearly two feet in diameter, which would be an ornament to a mineral cabinet.

2. *Green Tourmaline.* At Chesterfield and Goshen, Mass. (*Gibbs.*) These interesting localities have been so well described by Col. Gibbs, as to render any farther remarks unnecessary. (Am. Jour. Vol. I. p. 346.)

3. *Indicolite.* At Chesterfield and Goshen. (*Gibbs.*) At Bellows Falls. (*Silliman.*) At Hinsdale, New-Hampshire, in granite, in great abundance. (*J. A. Allen.*) This locality is found most readily by taking the road from Hinsdale to Winchester.

35. *Rubellite.* At Chesterfield and Goshen, Mass. (*Gibbs.*) See his account in the Journal of Science, as above cited.

36. *Feldspar.*

1. *Common Feldspar.* Near Haddam, greenish and translucent. (*McEwen.*) In the same vicinity it is of a light flesh color, and in large masses in granitic veins and beds. Also of the same color in pudding-stone, Deerfield. Also in large, bluish, imperfect crystals, in granite, Leverett. It occurs, of course, abundantly in all that part of the map colored as granite, gneiss and sienite.

2. *Adularia.* At Haddam. (*T. D. Porter.*) At West-Springfield and Southampton lead mine. (*Waterhouse.*) At Brimfield. (*Eaton.*)

3. *Siliceous Feldspar.* (*Gibbs.*) At Chesterfield, Mass. and Haddam. (*Gibbs.*) Also at Goshen—a new variety discovered by Dr. Hunt.

37. *Precious Emerald.* At Haddam? For a discussion of the subject whether this mineral exists in the United States, see Cleaveland's Mineralogy. Vol. 1. p. 341.

38. *Beryl.* At Brookfield, Huntington and Haddam. (*Silliman.*) Also at Litchfield. (*Brace.*) Also at Chatham. (*Mather.*) Also at Chesterfield, Mass. and Goshen. (*Gibbs.*) At Chesterfield and Haddam the crystals are sometimes from nine to twelve inches in diameter. At Goshen some are rose-colored. I found some crystals of beryl four or five miles north of the centre of Haddam.

39. *Garnet.* At Haddam—four inches diameter. (*Silliman.*) Also at Tolland, nearly rose-red. (*Webster.*) Also at the cobalt mine, Chatham, in mica slate, crystallized in rhombic dodecaedrons, or rather six-sided prisms terminated by three sided pyramids—the prisms often considerably elongated—color pale red—size that of a common musket bullet. Also at Plainfield, in limpid quartz, in trapezoedrons, or having at least as many as twenty-four sides—color of the mass nearly iron black. Found by J. Porter. Also at the same place in talco-micaceous slate, in dodecaedrons; color brownish red; size of a pea. Also at the same place, in dodecaedrons, truncated and striated on all their edges by hexaedral faces; presenting thirty-six faces in the whole—color dull red—size of a common bullet. Also at the same place in talcose slate, in dodecaedrons of the same color, sometimes two inches in diameter. Also at Chesterfield, Mass. with sappar, in trapezoedrons; color light rose-red—size of a pea. Also in hornblende and mica-slate, in Conway and Deerfield; color nearly black—crystals dodecaedrons—sometimes as large as a common bullet. Also in Conway, a loose mass, almost wholly made up of small black garnets in dodecaedrons—size less than one tenth of an inch in diameter, and with scarcely any difference in the size of hundreds. Also at Marlborough, Vermont, one mile south of the meeting-house, in dodecaedrons of a cherry-red, in chlorite slate; but hardly the precious garnet. They occur at this spot in immense quantities, and beautiful specimens may easily be obtained. A hundred other localities of the common garnet might be mentioned; since it occurs in all our primitive rocks: but the most interesting have been noticed.

1. *Pyrope.* At Brimfield, Mass. in granite, the feldspar of which is light green—in rounded irregular masses of a del-

icate poppy red, much resembling some varieties of the ruby. "It scratches crystallized quartz," says Professor Dewey, "and melts, rather hardly, into a dark enamel." Found in digging a well.

2. *Colophonite.* At Conway?

40. *Magnesian Garnet.* At Haddam. (Vide Cleaveland's Min. Vol. 2. p. 777.)

41. *Epidote.* At Milford Hills, in primitive greenstone. (*Silliman.*) Also at Litchfield and Washington, in graphic granite and sienite; crystallized. (*Brace.*) Also at Haddam, crystallized. Also at Tolland. (*Webster.*) Also at Athol, Worcester county, Mass. in prismatic bladed crystals, associated with black radiated schorl and hornblende. Also in Shutesbury, in small crystals in gneiss. It occurs also in a great many other places, disseminated in various rocks, and not very interesting.

1. *Zoisite.* At Haddam. (*Webster.*) Also at Wardsborough, Vermont, in much compressed, greenish grey, prismatic crystals; sometimes a foot long and one or two inches wide. (*Dewey.*) Discovered by Dr. J. A. Allen. Also at Leyden, Brattleborough and Westmoreland. (*Hall.*)

2. *Arenaceous Epidote.* At Haddam. (*Webster.*) Also at Shutesbury, Leyden, Shelburne, Buckland, Whately, Belchertown, Monson, and a great number of places, in hornblende and greenstone slate.

42. *Prehnite.* Near New-Haven, in secondary greenstone, in radiated masses, or in veins. Also at Woodbury, in the same sort of rock, in mammillary, botryoidal and almost globular masses. (*Silliman.*) Also between Simsbury and Wintonbury, in mammillary masses in greenstone. (*Hayden.*) Also in Deerfield, Greenfield, and, indeed, in almost every part of the secondary greenstone ranges from New-Haven to Gill; in all the forms mentioned above. In Deerfield the radiated masses sometimes contain pyritous copper. They occur there, also, on pseudomorphous quartz, having evidently been formed since the decomposition of the crystals originally occupying the cavities. In the same

place, I have found prehnite crystallized in groups on chalcedony; but could not determine the form of the crystal. Also near Bellows Falls in primitive rocks. I saw specimens in the cabinet of Dr. Wells; but was not informed of the precise locality: yet the mica attached to the specimens indicated their detachment from the older classes of rocks.

43. *Stilbite.* At Woodbury, well characterized. (*Silliman.*) Also at Deerfield in secondary greenstone; usually associated with chabasie. Its crystals appear to be right prisms, whose bases are rhombs with angles of about 60° and 120°. They rarely exceed one tenth of an inch in their longest direction. They are frequently grouped so as to become mere foliated masses. The lustre of the folia is pearly, and they are usually a little curved; color white. On hot coals it whitens and before the blow-pipe intumesces and melts into a white spongy enamel. It is but rarely met with.

44. *Zeolite.* Near New-Haven it is found in secondary greenstone, crystallized, or radiated, or mealy. (*Silliman.*) Also at Deerfield, in radiated fibrous masses, sometimes as large as a musket bullet, or more rarely an inch in diameter.

45. *Laumonite.* In secondary greenstone, also in loose rolled masses of pudding-stone near New-Haven. (*Silliman.*)

46. *Analcime.* At East-Haven, with chalcedony and agates. (*T. D. Porter.*) Also at Meriden, Connecticut. (*Silliman.*) Also at Deerfield, usually in laminated or radiated masses, which are reniform, cylindrical and nearly spherical. Very rarely in trapezoidal crystals—color white, grey and flesh-colored. Associated with calcareous spar, quartz, chalcedony, &c. and frequently effervesces a little with the acids.

47. *Chabasie.* At Deerfield, in cavities and seams in secondary greenstone; usually crystallized in transparent, or brownish, or yellowish crystals; presenting the primitive form, from one twentieth to one fourth of an inch in diameter, insulated and grouped on limpid, pseudomorphous and

tabular quartz, chalcedony, balls of zeolite, &c. Hundreds of specimens have been obtained at this place. To procure them, however, requires much labour.

48. *Apophyllite.* Near Saybrook, Connecticut. (Gibbs.)

49. *Tremolite.* At Milford, Washington, Goshen, Canaan, (Conn.) &c. in dolomite and granular limestone. (Silliman.)

A mineral is found at Leyden in great quantities, associated with quartz, limestone &c. and sometimes forming the gangue of the red oxid of titanium; the same occurs also at West Haven or Orange in hornblende—also at Leyden . at Colrain . at Shelburne . at Conway at Goshen . (Mass.) at Guilford and Brattleborough . Vt. and in various instances, in vast abundance: this mineral has generally been called *tremolite*, and sometimes *zoizite*, but it is probably *scapolite*.

50. *Asbestus.* At New-Haven and Milford, in serpentine, very beautiful. (Silliman.) Also at Pelham, Mass. where it occurs with serpentine and talc.

Amianthus. At New-Haven and Milford. Also at Washington. (Silliman.)

51. *Augite.* At Litchfield in dolomite—the whitish variety. (Brace.) Also at Brookfield and Washington in dolomite. (Eaton.) Also at Goshen, Mass. in granite, in flattened greenish gray prisms, sometimes eight inches long and two inches wide. This locality is one mile north of the meeting house, on the road to Ashfield. Also at Deerfield, in secondary greenstone, associated with quartz and calcareous spar, either in irregular veins or imperfect crystals—colour black—not abundant.

1. *Sahlite.* Near New-Haven in serpentine rocks belonging to the formation of verd-antique marble. (Silliman.)

52. *Common Hornblende.* This, of course, occurs in great quantities as a constituent of several rocks marked on the map; indeed, it may be found in a good degree of purity almost every where along the Connecticut, either in place or in rolled masses.

1. *Lamellar Hornblende.* Good specimens are found in Holland Mass. (Eaton.) Also in Leverett, Sunderland, Conway, &c. of a black colour, in Shutesbury it is green. It is found in sienitic granite and gneiss, in scales that are easily mistaken for black mica.

2. *Fibrous Hornblende.* At Leyden, the fibres very fine. Also near Bellows Falls, extremely beautiful, associated with quartz. Also in Shelburne, Conway, Goshen, &c. in mica slate, in large and broad fibres or lamellae.

3. *Fasciculite.* This is composed of fibres, or rather in many instances, of lamellae, frequently more than $\frac{1}{10}$ of an inch broad, diverging at both ends, so as to occupy usually, as many as 60° of a circle. These lamellae are commonly inserted perpendicularly to the folia of the slate in which they occur, and are applied to each other by their broader faces, being bent outwards on both sides, somewhat like a bow, and presenting elegant and very perfect fascicles. The fibres or lamellae, scarcely, if ever, cross one another; yet sometimes they diverge in nearly straight lines, and sometimes are so much curved as to resemble very exactly a sheaf of grain when standing erect. (See Plate 9,) The figure in the plate does not give a representation more regular or distinct than many of the most perfect specimens present. The length of the fibres or lamellae varies from one to four inches. It is found in mica slate and talco-micaceous slate in Hawley, Plainfield, and Conway. Probably this variety is comprehended under *Fibrous Hornblende* by Cleaveland; and perhaps specimens as perfect as those described above are not unfrequent. But so exact and striking an instance do these exhibit of the fascicular structure of minerals, that I could not resist the temptation to denominate them *Fasciculite.*

4. *Hornblende Slate.* For an account of this, see the Geological part of this sketch.

53 *Actynolite.* At Saybrook, and near N. Haven in serpentine. (Silliman.) Also at Litchfield. (Brace.) Also at Middlefield. (Dewey.) Also at Hawley. (Eaton.) Also at Cummington. (J. Porter.) Also at Windham in compressed

four sided prisms, in steatite and talc; the specimens superb. (Hall.) Also at Chatham Ct. near the bank of the river opposite the upper ferry in Haddam, in an enormous granitic vein; associated with black schorl, magnetic oxide of iron, &c. Also at Belchertown. Also at Shutesbury in gneiss. Also at New Salem in acicular crystals in chlorite. Also at New Fane, where it was discovered by Dr. J. A. Allen. It occurs in steatite in four sided, sometimes very perfect, sometimes flattened and striated crystals, five or six inches long, often half an inch broad, generally radiated, sometimes curved and crossing one another. The colour is a dark beautiful green, and the specimens are very elegant.

54. *Anthophillite.* It is said to have been found near Saybrook (Cleaveland's Mineralogy.)

55. *Diallage.* In serpentine rocks near New-Haven—well characterised. (Hall.) Also in Conway? in granite.

56. *Macle.* At Bellows Falls Croyden, Cornish, Charlestown, Langdon and Alstead in argillite. (Hall.) According to Mr. Nuttall, the foliated mineral occurring so abundantly in the mica slate in Chesterfield, Plainfield, Hawley, Heath, &c. being usually inserted in small bronze coloured plates, nearly at right angles with the folia of the slate, may be macle.

57. *Serpentine.*

1. *Precious Serpentine.* At Milford, in nodules or irregular masses in primitive limestone. (Silliman.)

2. *Common Serpentine.* In extensive beds and variously blended with limestone at Milford and New-Haven, forming the Verd Antique. (Silliman.) Also at Westfield in granite. (Eaton.) Also at Middlefield, associated with steatite. (Dewey.) Also at Grafton, Windham and Putney, Vermont, in large insulated masses weighing many tons. (J. A. Allen.) Also at Pelham Mass. in a large loose mass penetrated by asbestus and associated with talc. Also at Leyden, Shelburne, Deerfield, &c. in small rolled masses.

58. *Talc.*

1. *Common Talc.* At Haddam, Litchfield and Southampton. (Cleaveland) Also at Cummington in steatite. (J. Porter.) Also at Middlefield in steatite. (Dewey.) Also at Windham in steatite—laminæ very large and beautiful. (Hall.) Also in New Fane in steatite—specimens laminated and elegant. (J. A. Allen.) Also at Pelham, associated with serpentine and asbestus. Also at Rowe.

2. *Indurated Talc.* At Milford marble quarry. (Silliman.)

3. *Scaly Talc.* At Windham and New Fane. (J. A. Allen,)

59. *Steatite.*

1. *Common Steatite.* Near New-Haven and at Litchfield. (Cleaveland.) Also at Middlefield connected, with serpentine and mica slate, and crystallized in six sided prisms terminated by six sided pyramids. (Dewey.) Also at Grafton and Windham. (Hall.) Also at New Fane and Marlborough. (J. A. Allen.) Also at Savoy and Cummington (J. Porter.) Also at Westminster, Vermont, where, as well as at Grafton, it is wrought into aqueducts and answers a valuable purpose. Also at New Salem forming a bed in gneiss.

2. *Potstone.* At Grafton, Vermont, in large quantities. (Hall.)

60. *Chlorite.*

1. *Common Chlorite.* Near New-Haven, penetrating quartz and calcareous spar, and in greenstone. (Silliman.) Also at Saybrook, crystallized. (T. D. Porter.) Also at Wardsborough, Vermont, in dark green folia. (Dewey.) Also at Halifax, Leyden, Conway, &c. foliated. Also at Miller's Falls in Montague penetrating milk white quartz. Also at New Salem. Also in greenstone amygdaloid at Deerfield, Greenfield, Gill, &c. It fills two thirds of the cavities in some varieties of greenstone, and to the naked eye has a radiated aspect, but Professor Dewey remarks,

that it does not appear to be radiated under a magnifier, great or small; but to consist of folia curiously arranged often with no regularity and their length somewhat greater than their breadth."

2. *Chlorite Slate.* For an account of this, see the map and the Geological part of this sketch.

3. *Green Earth.* A part of the chlorite described above in the amygdaloid in Deerfield, &c. appears to belong to this variety.

61. *Argillaceous Slate.*

1. *Argillite.*

2. *Shale.*

3. *Bituminous Shale.* For a description of these minerals the reader is referred to the Geological part of this sketch.

62. *Claystone.* This is found in rolled peices in the bed of Connecticut river below where it cuts through the coal formation at Gill; and probably this mineral is worn from thence by the water. The pieces frequently occur in the form of a prolate spheroid, sometimes flattened, even to the shape of a wheel, and sometimes assuming shapes bearing a resemblance to the sculptured images of Persia and India. It is opaque—colour, light gray—scarcely adheres to the tongue, and yields a slight argillaceous odour—fracture dull and uneven, a little conchoidal—easily scratched with a knife and even by the finger nail; yet its particles scratch iron. It does not effervesce with acids.

63. *Clay.*

1. *Porcelain Clay.* At Washington Ct. in small quantities. (Cleaveland.) Also at Plainfield (Silliman.) Also at Conway and Leyden in small quantities.

2. *Potters Clay.* In the older alluvion along the Connecticut, abundant.

3. *Loam.* In the newest alluvion along the Connecticut.

4 *Fuller's Earth.* At the bed of iron ore in Kent. (Silliman.)

64. *Sulphur.* This occurs pulverulent in small quantities in mica slate, in Warwick, Shelburne, Conway, &c. Perhaps it proceeds from the decomposition of some sulphuret.

65. *Graphite.* At Cornwall, Connecticut. (Brace.) Also at Tolland. (Webster.) Also at Hebron and Sharon. (Cleaveland.) Also between Sturbridge and Holland, *Mass.*

66. *Coal.* At Durham, Middletown, Chatham, Southington, Berlin, Suffield, Enfield, Somers, Ellington and South Hadley. (Silliman.) Also in the drift of the Southampton lead mine. From some of these localities, the coal is highly bituminous, in others scarcely so at all.

67. *Lignite.*

1. *Jet.* At South Hadley. (Gibbs.)

68. *Peat.* In small quantities at Leverett, Mass.

69. *Native Silver.* At Huntington in the bismuth mine. Also at West River Mountain, Chesterfield, New-Hampshire. (Silliman.) After the remarks and explanations given by Prof. Silliman. (Am. Journ. Sci. Vol III. p. 74. note,) no reasonable doubt can remain concerning this last locality.

70. *Sulphuret of Silver.* In Connecticut it is said to have been found. (Cleaveland's Mineralogy.)

71. *Native Copper.* At Bristol, Connecticut, in a vein with the red oxide of copper. (Gibbs.) Also on the Hamden hills, a mass of about ninety pounds, adhering to the rock. Also twelve miles from New-Haven near the Hartford turnpike, a mass of six pounds in alluvial soil. (Silliman.) Also at Whately, Mass. in geest, on the limit between the primitive and alluvial soil, and about five miles

from secondary greenstone or the coal formation. The piece weighs seventeen ounces and very much resembles the last mass above described, exhibiting imperfect rudiments of octaedral crystals on the surface, and being encrusted by green carbonate of copper. The cavities also contain a very little red oxide of copper.

72. *Sulphuret of Copper.* Near New-Haven, at Simsbury mine, &c. (Silliman.)

73. *Pyritous Copper.* At Cheshire, Simsbury, &c. (Silliman.) Also at the Southampton lead mine, where it occurs amorphous and crystallized in regular tetraedrons which are insulated on calcareous spar. For the specimens containing these crystals, I am indebted to Dr. David Hunt. Also at the Leverett lead mine amorphous. Also in greenstone, Deerfield. Also at Greenfield in veins, in greenstone and sandstone.

74. *Variegated Pyritous Copper.* This occurs sparingly disseminated in calcareous spar in sandstone of the coal formation. In the island in the middle of Connecticut river at the falls in Gill. I am indebted to Prof. Dewey for the determination of this mineral.

75. *Antimonial Gray Copper.* Near Hartford, in the red sandstone formation. (coal formation ?) (Maclure.)

76. *White Copper.* At Fairfield ?* Connecticut. (Silliman.)

77. *Red Oxide of Copper.* At Bristol, in a vein with native copper. (Gibbs.) Also with native copper in the greenstone mountains extending northerly from New-Haven. (Silliman.)

78. *Green Carbonate of Copper.* At Greenfield, near the Falls in Gill, in two veins with pyritous copper, in considerable abundance near the surface. It is amorphous and even earthy.

* There is great reason to believe that this locality is not correct.—*Editor.*

1. *Fibrous Malachite.* At Cheshire, &c. in small but good specimens. (Silliman.)

79. *Arsenical Iron? or Arsenical Sulphuret of Iron?* At Gill in a loose mass weighing several pounds. Found by Dr. Alpheus Stone.

80. *Sulphuret of Iron.* (Pyrites—Iron Pyrites.) This is found in every town and in almost every rock along the Connecticut; as in the bituminous shale at Westfield and Sunderland, compact and amorphous; also in other rocks of the coal formation. Also at Plainfield, disseminated in limpid quartz. Also at Hawley, compact and unmixed with any gangue. Also at Halifax, Vermont, in an immense mass found in digging a cellar. Also with micaceous oxide of iron at Montague. Also at the Southampton lead mine, beautifully crystallized in octaedrons which are truncated in all their angles. It is grouped or insulated on crystallized quartz, and the crystals are about as large as a small shot, yet perfectly distinct and well marked.

81. *Magnetic Sulphuret of Iron.* At Brookfield, abundant in granite. Also at Huntington with bismuth, &c. (Silliman.) Also near Woodbury in gneiss. (Eaton.)

82. *Arsenical Sulphuret of Iron.* At Derby Middletown, and the Chatham Cobalt mine. (Silliman.) Also at Leicester, Mass. in gneiss. (Dewey.)

83. *Magnetic Oxide of Iron.* At Somerset, Vermont, in beds from one inch to two feet thick, in mica slate. (J. A. Allen.) At Chatham, near the bank of the river, opposite the upper ferry in Haddam, in a granite vein with schorl, actynolite, garnets, &c. The crystals are octaedrons, well defined, and often nearly an inch in diameter. Also at Plainfield, Shelburne, Athol, Shutesbury, &c. in smaller octaedrons in mica slate and gneiss. Also in beds in talcose slate at Hawley. Also in beds in Bernardstown.

1. *Iron Sand.* At West Haven beach abundant. (Silliman.) Also on the beach near the Light House in East Haven in great abundance. Also a little below Turner's Falls in Gill, on the southeast bank of Connecticut river.

84. *Specular Oxide of Iron.* Sometimes covering quartz and other minerals; as at New Fane and Leyden; but not abundant.

85. *Micaceous Oxide of Iron.* At Jamaica, Vermont, in dolomite; very handsome. (*J. A. Allen.*) Also at Hawley and at Montague: for a description of which, see the general view of mineral veins and beds that precedes this list of minerals.

86. *Red Oxide of Iron.*

1. *Scaly Red Oxide of Iron.* At Kent, Connecticut. (*Gibbs.*)

2. *Red Hematite.* At Kent. (*Gibbs.*)

87. *Brown Oxide of Iron.*

1. *Brown Hematite.* At Salisbury and Kent, Connecticut. (*Silliman.*) Also at Westriver mountain in Chesterfield, New-Hampshire, in mica slate.

88. *Argillaceous Oxide of Iron.*

1. *Granular Argillaceous Oxid of Iron.* At Salisbury. (*Cleaveland.*)

2. *Nodular Argillaceous Oxide of Iron.* At Putney, Vermont, in beds of common clay. The masses are oval and elongated, embracing an earthy nucleus. Also near the falls in Gill, in a dark hard slate of the coal formation.

3. *Bog Ore.* At New Braintree, Massachusetts, where it is wrought—also at Greenfield.

89. *Carbonate of Iron*, (spathic iron.) At New-Milford, in abundance, (*Silliman.*)

90. *Sulphate of Iron.* Efflorescing on mica slate in small quantities in Conway, Hawley, &c.

91. *Chromate of Iron.* At New-Haven and Milford; dis-

seminated in the verd Antique marble. (*Silliman.*) Also at Middlefield in serpentine. (*Eaton.*) Also at Cummington, well characterized and almost exactly resembling the Baltimore chromate ; in a loose mass—Found by Dr. J. Porter.

92. *Sulphuret of Lead.* At Middletown, Southington, and Huntington, where it is uncommonly argentiferous, and at Bethlehem, (Silliman.) Also at Berlin, (Percival.) Also at Southampton, Montgomery, Hatfield, Leverett, where are two localities, and Whately. At these places the structure of the ore is commonly foliated, sometimes granular and sometimes in cubical crystals.

93. *Carbonate of Lead.* This exists in the cavities of the matrix of the lead mine at Southampton. Its colour is white or mixed with yellow. Before the blow pipe it decrepitated and readily yielded a globule of lead. It occurs crystalized as follows.—1. Two six sided pyramids united at their bases and deeply truncated at their apices—making fourteen faces to the crystal.—2. A six sided prism, terminated by four sided pyramids, two of the faces being enlarged—fourteen faces to the crystal.—3. Tabular prisms with bevelments on the edges ; but the precise form I could not determine. These tables frequently cross one another.

94. *Carbonated Muriate of Lead.* At the Southampton lead mine in light green groups of cubic crystals, terminated by tetraedral pyramids. (Meade.)

95. *Sulphate of Lead.* At Huntington with argentiferous galena. (Silliman.) Also at Southampton lead mine, in plates or tables on galena. (Meade.)

96. *Phosphate of Lead.* At Southampton lead mine, in light green spherical masses, having a radiated structure.

97. *Molybdate of Lead.* At Southampton lead mine in tabular, wax yellow crystals. (Meade.)

98. *Sulphuret of Zinc.* At Berlin. (Silliman.) Also at Southampton lead mine, foliated and crystallized. The

crystals are so grouped that it is difficult, in the specimens which I saw, to seize upon the precise form. I think, however, I found the octaedron with truncated pyramids. Also at Leverett, foliated.

99. *Arsenical Nickel.* At Chatham, associated with arsenical cobalt. (Pierce and Torrey.)

100. *Arsenical Cobalt.* At Chatham. (Silliman.)

101. *Arseniate of Cobalt.* At Chatham. (Pierce and Torrey.)

102. *Oxide of Manganese.* At Leverett, in alluvial soil forming a bed five or six inches thick a few inches below the surface. It is in rounded irregular masses from the size of a pea to an inch in diameter and considerably resembles granular oxide of Iron. Also at Deerfield; forming crusts on quartz and mica slate.

103. *Native Bismuth.* At Huntington. (Silliman.)

104. *Native Antimony.* At Harwinton, Litchfield county, in broad plates. (Silliman.)

105. *Sulphuret of Antimony.* At Harwinton.* (Silliman.) Also near South Hadley. (Gibbs.)

106. *Native Tellurium.* At Huntington, associated with tungsten, bismuth, silver, &c. (Silliman.)

107. *Sulphuret of Molybdena.* At Saybrook. (T. D. Porter.) Also at East-Haddam and Shutesbury. (Silliman.) Also at Brimfield. (Eaton.)

108. *Yellow Oxide of Tungsten.* A new species discovered, analyzed and described by Professor Silliman. At Huntington in a gangue of quartz.

109. *Calcareous Oxide of Tungsten.* At Huntington. (Silliman.)

110. *Ferruginous Oxide of Tungsten.* At Huntington. (Silliman.)

* 104 and 105 need confirmation.—*Editor.*

111. *Red Oxide of Titanium.* Near New-Haven—also at Oxford in large geniculated crystals in mica slate—also at Huntington, at the bismuth, mine;—crystals as large as the thumb and geniculated. (Silliman.) Also at Litchfield, sometimes reticulated on mica slate. (Brace.) Also at Worthington, Massachusetts, in quartz. (Brace.) Also at Leyden, in four or eight sides, often handsomely geniculated, generally striated, crystals, in limpid quartz, tremolite and hornblende. Some of the specimens have several geniculations and are as large as the thumb. Hundreds of good specimens have been collected at this locality. Also at Brattleborough, Colrain, Shelburne, and Conway, in quartz, mica slate and tremolite. At Shelburne I found its crystals penetrating a vein of quartz in mica slate in place. In Conway a few small crystals have been observed exhibiting the primitive form and presenting the "kind of twin crystal," described in Rees Cyclopedia, Art. Rutile. This mineral, indeed, may be found in almost any spot between Conway and Brattleborough, on a strip several miles wide.

112. *Silico-Calcareous Oxide of Titanium.* At Brattleborough, near the north line of the town in a bowlder of granite, which has flesh coloured feldspar—colour dark brown, or chesnut. Some of the crystals appear to be six sided prisms. (Dewey.) These prisms are terminated, if I mistake not by three sided pyramids. I also noticed a four sided, flattened and striated prism, whose terminations could not be determined.

113. *Ferruginous Oxide of Columbium.* At Haddam, in granite. (Berzelius and Torrey.)

Remark.—Since the above list of localities was completed the following have occurred; but as they cannot be conveniently inserted in their proper places they may be mentioned here.

Fibrous Limestone, Satin Spar, in bituminous shale—with Ichthyolites at Sunderland. *Andalusite,* at Litchfield. Delafield.

GEOLOGY, MINERALOGY, TOPOGRAPHY, &c.

OF THE CONNECTICUT.

PART III.

Scenery.

BETWEEN the geology and scenery of a country. there is an intimate and interesting connection. Let the experienced geologist be placed upon an eminence, and the contour of the surrounding region will enable him to decide with a good degree of probability, concerning the nature of its rocks. The plain will at once be pronounced alluvion. The swelling hillock or ridge with mural faces—if their aspect be dark—indicate some member of the trap family; if light coloured. they indicate granite. The conical elevation of a reddish hue will be immediately referred to old red sandstone. And those moderately steep hills, that stretch away over many a league, and form continuous and extensive

* For the map and drawings see Vol. VI. No. I.

mountain ranges, will be known as mica slate, or gneiss, or some other rock of a schistose structure.

Such is in fact the aspect of the country along the Connecticut; and of course we here find a rich diversity of scenery, so that not only the geologist, but the poet and the painter, and every man of correct taste, will find an interest in its beauties. My object at this time is to refer to a few of the most interesting and romantic spots along this river, annexing a short description to each; in which I shall be most particular concerning those with which I am most familiar. It is not in my power to describe these scenes with the skill of the poet or the painter: But if I can succeed in inducing the traveller to visit them, it will be to him a more agreeable disappointment to have the reality exceed the description, than fall short of it.

East and West Rock.

The eminences thus named have long been celebrated, and attract the attention of the visitor who first enters the harbour or the city of New-Haven, as most singular features in the landscape;—the one lying north west and the other north east, about two miles distant. They present their naked fronts towards the city, nearly four hundred feet high, of an iron rust colour; the original dark brown aspect, being at East Rock principally destroyed by the stone quarrymen, who have, with great boldness, undermined nearly the whole of the front columns for the purposes of architecture. In ascending these cliffs, we find them to be greenstone based on sandstone.* But when the visitor reaches their top, he will find his attention diverted from the rock on which he stands, to the rich and varied prospect that stretches beneath his eye. New-Haven, with her *long line* of colleges and elegant churches on the one side, and her extensive wharf on the other, is an interesting object; and suggests to the mind a great variety of agreeable associations. Beyond the city the spectator sees the harbour, gradually widening outwards, till it is lost in Long Island Sound; and low in the horizon, he observes the sandy

* *Cactus opuntia* L. grows on these rocks as a native.

hills of Long Island.* On either side of the harbour the country gently rises into hills of moderate elevation, and is pleasantly diversified with cultivated and uncultivated patches; and often the neat mansion is seen half covered by the trees.

East and West Rock become interesting objects to the students of Yale College, being associated with a thousand grateful recollections. To these cliffs they often resort in the hour of relaxation, to enjoy the pleasures of a rich and diversified landscape, to study the geology of the trap rocks and to breathe the serener and more bracing mountain air. Who of them, while standing there, and seeing the white crested waves breaking on the rocky shore, will not remember the ill omened cliffs of Kinsale.

Prospect Hill, East-Haven.

Professor Silliman led me to the top of this beautiful greenstone hill, which rises scarcely an hundred feet above the harbour; but, from its top, the prospect is extremely interesting. New-Haven is presented to you in a direction nearly opposite to that in which it is seen from East or West Rock; and the view is, in some respects, superior. East and West Rock, seen from this hill, are themselves striking objects in the rear of the city; constituting the most prominent part of that amphitheatre of hills, which almost encloses New-Haven. Still further back, mount Carmel and the Berlin mountains may be seen as you look up the valley of Wallingford River; and other mountains beyond these till they insensibly mingle with the heavens. Directly in front of the observer, on the west, is New-Haven harbour; and a fine opportunity is afforded for witnessing the ar-

* A few years since, as I was crossing the salt marsh at the foot of East Rock, in company with Doct. A. Monson, I observed, on looking towards Long Island, an uncommon instance of refraction. The shore of that island appeared several degrees higher than usual and uncommonly distinct. Indeed, its altitude seemed as great, as it did a few days previous, when I happened to be sailing within two or three miles of it. It was about noon when this phenomenon was noticed in a clear very hot day of July; the thermometer standing but little below 90°. Did the rapid evaporation produce so great a degree of cold, and consequent condensation of the air near the surface of the water, as to cause this extraordinary refraction?

rival and departure of vessels. Indeed, the beauty of the prospect from this spot is much greater than one would suppose possible from such a mere hillock. The top of the eminence has a circular redoubt upon it, which was constructed by the inhabitants of New-Haven during the Revolutionary war, and repaired during the late war with Great-Britain. The ditch is dug in solid greenstone; but fortunately not being wanted, it is now abandoned, and has become the resort of the flocks that graze in the field; the magazine serving as a place of shelter from the storm.*

Eminence in West-Haven.—(Now Orange.)

Near the western line of this town, one or two miles south of the turnpike from New-Haven to Milford, is an elevated swell of land, which commands an extensive and delightful prospect. When I visited it, a thick fog was just breaking away and developing one object after another, till, at length, the coast of Connecticut from East-Haven to Stratford, and not less than fifty or sixty miles of the coast of Long Island became visible, as well as the villages of Milford and North-Milford; and just rising over the trees, appeared the spires of New-Haven. I know not any specific appellation for this commanding *plateau*.

Prospect from Middletown, Upper Houses.

At the north end of the village thus denominated, a few rods from the public house, is a hill, from whose summit is obtained a fine view of the basin in which Middletown is placed, with the city and the river. Here too I had the pleasure, on one occasion, of seeing the various objects of this landscape, artificial and natural, partially covered by a fog; the spires of Middletown and the more elevated trees and hills appearing above it, and reminding me of the antediluvian world half buried in the deluge.

* Attached to the red conglomerate at the foot of this hill, I found the beautiful *Borrera chrysophthalma* Ach: And this is the only place in which I have ever seen it in New-England, except upon the puddingstone of Roxbury, Mass.

Monte Video.

This is a particular part of Talcot Mountain, eight miles northwest of Hartford, at the top of the greenstone ridge extending from Berlin to Amherst. It affords one of the most interesting prospects (and with the exception, perhaps of Holyoke, the *most* interesting) to be found along the Connecticut. "The diameter of this view, in two directions, is more than ninety miles;" and the spires of more than thirty churches are visible, scattered through the broad and delightful vallies on the east and west sides of the eminence. The beauties and sublimities with which nature has invested this spot, both on a limited and an extensive scale, are greatly increased by the displays of an enlightened and correct taste in the disposition and adaptation of the various objects which this singular country residence exhibits; such as the tenant's house in Gothic style; the summer house; the boat upon the mountain lake, and rising in Gothic grandeur above the trees, the hexagonal tower, whose top is nine hundred and sixty feet above the Connecticut. But after the minute and accurate description given by Professor Silliman of these objects and this view, it is altogether unnecessary in this place to go into particulars. To the "Tour between Hartford and Quebec" the reader is with pleasure referred for a complete account of the scenery of Monte Video, which, in some respects, is altogether unique in this part of the country.

Along the same extensive ridge of greenstone, there are, no doubt, many other peaks commanding views of delightful landscapes; but not having visited them, nor seen any account of them, I am of course unable to describe them.

Mount Holyoke.

This is another of the commanding watch towers of the Connecticut. The view from its top is delightful; and the traveller, whether he be a lover of natural scenery, or a geologist, will find himself amply repaid for turning aside half a day to visit its summit.

Does he look from this elevation with an eye that is accustomed to range with pleasure over a variegated land-

scape? Here then will he find many forms of beauty and grandeur impressed upon the works of God and man around him. Immediately before him on the west and north, are extensive meadows, through which the Connecticut winds in silence and majesty; and as if to pay a tribute of respect to this venerable mountain, it here forms a graceful curve of three miles in extent, while its actual advance towards the ocean, scarcely exceeds fifty rods. These meadows are in a high state of cultivation, and during the summer months, the parallel strips, luxuriant with different vegetables, present a charming variety. Just beyond the Connecticut, on the western margin of the meadows, lies the beautiful village of Northampton, vieing for situation and elegance with any country town in New-England. So distinct is the view of this place from Holyoke, that with the naked eye the inhabitants may be seen as they walk the streets; while their spacious and elegant house of worship, a fine Court House,* and many seats of private gentlemen rise in a rich and diversified relief. A little to the right, in the same valley, the neat villages of Hadley and Hatfield, and still farther to the east, Amherst, with its meeting house and collegiate edifices on a commanding eminence, form resting points in this great basin, on which the eye reposes with pleasure. To the north of these villages the valley of the Connecticut is gradually narrowed by the encroachments of the highlands, until at the distance of about twenty miles, they close in upon it, and beyond this point, a sea of mountains displays ridge above ridge and peak above peak, even to the lofty range of the Hoosack and Green Mountains, at the distance of fifty or sixty miles. Southwest appears Mount Tom, a few miles distant, separated from Holyoke by the deep gulf through which the Connecticut flows; and fifty miles distant, in the northeast, rises the "cloud-capt" Monadnock.

Turning southerly, the observer will have a full view of the broad valley extending from Holyoke to Middletown; a distance of more than fifty miles. He will be able to trace the river, in all its windings, as far as Long Meadow,

* Recently destroyed by fire.

which is twenty miles distant; and by an optical deception,* it seems to ascend the whole extent, about as much as it in reality descends; appearing at the farther extremity, to be nearly on a level with the eye. Many pleasant villages are visible along the river; among which, as most striking, may be named Windsor, East-Windsor, Springfield, West-Springfield, and South-Hadley and Granby, almost beneath the eye: and these, with the many spires of other villages just visible above the trees, and the alternate patches of cultivated and uncultivated ground, checkering the plain, give a liveliness and interest to the commanding landscape.

I sat down on this eminence, on a clear summer day, with a telescope whose power was 40; and after the first thrill of admiration, produced by the general view of the scene around me had subsided, I began to examine, one by one, the objects before me through the glass. The hour divisions and indices, on the dial plate of Northampton meeting house, were as distinct as those on my watch in my hand;—and I presume an acquaintance might easily have been recognized in the streets of that place. The divisions, &c. on the dial plate of South-Hadley meeting house, five miles distant, were also very distinct. By moving the telescope slowly over the distant landscape, many spires of village churches, that were unnoticed by the naked eye, passed over its field; and, with little effort, I numbered twenty-four.

It is a general opinion that East and West Rock are visible from Holyoke. But I am satisfied that the two perpendicular bluffs appearing in that direction, are those between Berlin and Meriden; and that these conceal the New-Haven eminences. On turning the telescope, however, so as to point between the two precipices that are visible, I perceived, near the horizon, a low range of hills, about as distinct as the belts of Jupiter; which, I have little doubt, were a part of Long Island.

Suppose, next, that the man, who visits Holyoke, is a geologist. He has reached an interesting spot, if he look no farther than the naked trap on which he stands. But he will find his attention, on first visiting this pinnacle, irre-

* Explained by the common principles of perspective.

sistibly drawn to the striking and diversified geological features before him. For he has a view of nearly all the secondary region, extending from New-Haven about 110 miles northerly; and he sees a vast extent of primitive on its borders. As he casts his eye over this extensive tract, he perceives many of those grand characteristics of the different rock formations, which are not derived from their composition, but from a contour, peculiar to each, given by the Almighty Hand that originally produced them: So that if this geologist were unacquainted with the nature of the rocks before him, he would be able to say, with a good degree of confidence;—yonder hills to the south, so precipitous on the one side, and gradually sloping on the other, must belong to the trap family. But these extensive unbroken mountain ranges on my right and left, rising so gradually, must be primitive; and this intervening valley is doubtless alluvion. And on turning his eye northerly, he will pronounce the rounded Sugar Loaf and Toby to be sandstone. But it would increase his pleasure, were he to be informed that the former is the Wernerian old red sandstone, and the latter a peculiar conglomerate of the coal formation, separated from the red sandstone by a ridge of greenstone; and that its venerable head overshadows the coarsest granite, and that at its base, pressed down by its enormous weight, may be found cemeteries of fishes that swam in some antediluvian stream. He may be pointed also to the South-Hampton vein of lead ore in its whole extent; and to the localities of the beautiful beryls, sappars, tourmalines, &c. of Haddam and Chesterfield.

This geologist cannot but perceive that the extensive valley, north and west of Holyoke, must, at some remote period, have been covered by the waters of the Connecticut, ere the passage between Holyoke and Tom was worn through—And he will also conclude, that another similar, but much larger lake, must have existed in the extensive basin south of Holyoke, before the waters of the Connecticut had forced a passage through the mountains below Middletown. Hence he will be led to speculate upon the period when these waters began to subside and upon the time requisite to wear away such immense masses of rock: and ere he is aware, his thoughts will be led back to the period, when the cataract of Niagara began its seven mile

retreat, or when the deltas of the Mississippi and Ganges, began to encroach upon the ocean, or even to that time when "all the high hills that were under the whole heaven were covered" with a deluge.

Last of all, his attention will be directed to the rock on which he stands. And he will find near him those regular columns and those sloping *debris*, that evince it to belong to the trap family, so singular in its structure and position, and whose origin is so hard to be accounted for.*

Mount Tom.

Mount Tom is higher than Holyoke and the prospect from its top is grand and extensive, but there is not that interesting grouping of objects in its immediate vicinity; and while Holyoke attracts so many visitors, Tom is rarely ascended. Both mountains are merely distinct peaks of the same greenstone range, separated by Connecticut river.

Sugar Loaf.

It has already been stated that this is a conical elevation of old red sandstone, rising five hundred feet above the Connecticut, in Deerfield, immediately on its banks. Any one passing along the stage road from Whately to Deerfield, will be struck with the singular form and aspect of this peak, and he will not regret a visit to its top. This he will find to be an ellipse, whose diameters are about ten and thirty rods. On the east and west sides are perpendicular walls several hundred feet high. Connecticut river is a beautiful object on the east and south, and a bridge across this river, and the village of Sunderland on the opposite bank, appear to be distant scarcely a stone's throw. One fourth of the horizon is hidden on the north east by the trees. On every other side the view is distinct and commanding.

In the meadows near the south point of Sugar Loaf, a skirmish took place in August, 1675, between the Indians and the Massachusetts forces under Captains Lathrop and

* It ought perhaps to be mentioned that recently two commodious buildings have been erected upon Holyoke, where the visitor will find ample means of refreshment.

Beers ; in which the former were defeated with considerable loss. And in the plain on the west side of the mountain, at a little distance, this same Capt. Lathrop, in September 1675, was drawn into an ambuscade and cut off with his company, consisting of eighty "young men, the very flower of the County of Essex." Hence the parish of Muddy Brook, which was originally called Bloody Brook, derived its ancient name.

On Sugar Loaf a two story building has recently been erected for the accommodation of visitors.*

Mount Toby.

This eminence is two or three miles northeast of Sugar Loaf, on the east side of Connecticut river in Sunderland. It is made up of the slates and pudding-stones of the coal formation, and is little less than one thousand feet higher than the river, and twice as high as Sugar Loaf. The view from its summit is, of course, more extensive : but as it embraces for the most part the same regions that are seen from Holyoke and Sugar Loaf, it is unnecessary to be more particular.

Deerfield Mountain.

At the highest point of that range of old red sandstone extending from Sugar Loaf to Gill, that is, a little south of the village of Deerfield, on the east, is a prospect, which, in one respect, is more perfect than any along the Connecticut. It is not very extensive ; but the basin in which Deerfield village stands, presents a picture of rural beauty of singular delicacy and luxuriance. The village, lying at the foot of the mountain and running parallel to it, appears so much beneath the eye, that almost every building in it is dstinctly v.sible. Beyond this, lies one of the richest interval tracts to be found in New-England, through which the Deerfield river meanders most beautifully ; and beyond these meadows, is an amphitheatre of mountains.

* Growing out of the almost naked rock on the top of the Sugar Loaf, I noticed the following rather rare and interesting plants : Asclepias verticillata. Artemisia canadensis, Arbutus uva ursi, Clinipodium vulgare, Poa quinquefida, Celtis occidentalis, &c. &c.

*West River Mountain.**

This is one of those precipitous and partially insulated peaks of mica slate that occur along the Connecticut, and which at a little distance, are often mistaken by the geologist for greenstone hillocks. It is nine hundred and forty feet above the Connecticut, and stands on its eastern bank, directly opposite to the east village of Brattleborough. That village and the intervening river are the most interesting objects in the landscape that is seen from this mountain. One fancies himself almost able, by a single leap from the summit, to throw himself into the village. Almost every other part of the landscape exhibits a tumultuous sea of moun-

* Tradition has made this mountain volcanic in former days: but observation discovers no traces of eruption. The experienced eye of Col. Gibbs (a gentleman who will always be reckoned among the fathers of American mineralogy and geology, first detected the error. (See Bruce's Min. Jour. No. 1. p. 19.) While I agree with him that the notion of flames said to have been seen issuing from this mountain arose "from a popular superstition through the country, that the presence of the precious metals is frequently indicated by a flame which arises from the ground at night," I am disposed to adopt the explanation of the accompanying "thunder," given by Dr. Allen; (Jour. Sci. Vol. 3 p. 73) who accounts for this "by the falling of immense masses of rock." That immense masses of rock have fallen, not only from the cliff* to which Dr. A. refers, but also from the western face of the mountain, no one will deny who has visited the spot: and that the falling of these would produce a "noise like thunder," which would be heard two or three miles, no one will doubt who has chanced to be in New-Haven when the quarrymen had undermined one of the huge columns of East Rock and it was precipitated upon the base below. Although two miles distant, the report in the city is often as loud as a six pounder.

In passing over West River Mountain a few years since, near the top a rattle snake was announced; or rather he announced himself by the thrilling shake of his rattles. Doct. ——, (who had been a companion of Wilson the ornithologist in one of his pedestrian tours through the western wilderness,) immediately despatched the snake and found him to measure above four feet in length. I mention this fact because it is uncommon in these days in this section of the country to meet with these reptiles. Indeed, I have never met with another one alive along the Connecticut, with *perhaps* one exception. I recollect however, meeting some years ago a man in Leverett, who was *barefoot* with several rattle snakes dangling over his shoulders, who told me he had been hunting them at their den.†

* On the fragments of rock at the foot of this cliff, among other interesting lichens grows the *Stereocaulon paschale* Ach.

† Rattlesnakes are occasionally killed on all the greenstone ranges of New England, from which they will probably never be entirely extirpated; a dried one is now before me measuring three feet six inches in length which was killed last summer on the Woodbridge greenstone ridge near New-Haven.—*Editor, March* 6, 1823.

tains; Black mountain on the one hand, and the Monadnock on the other, being prominent, and here and there, a spire, or a village, crowning a hill, or enlivening the valley.

Black Mountain.

A general description of this mountain has been given in the geological part of this sketch, and I mention it here as presenting an interesting view from its summit.

Fall Mountain.

There is a great resemblance between the situation and appearance of this and West River Mountain. Both are of mica slate—both are nearly of the same height—both are precipitous on the west side—both stand on the east bank of the Connecticut—both have a pleasant village opposite to them on the west bank, and both a bridge across the river directly in front. Bellows Falls village is nearer the base of the mountain than Brattleborough, because the river is there narrower. The observer from the top of Fall Mountain looks down almost perpendicularly upon the Connecticut, here reduced to a few rods in width, and foaming and falling among the jutting rocks, presenting an image of disorder and danger, while the neat village on the river's bank exhibits an image of peace and security.

Numerous other eminences in the primitive mountain ranges on either side of the Connecticut, command extensive and interesting prospects. But the most conspicuous have been described, it is unnecessary to go into farther particulars.

Bellows Falls.

Every thing at this romantic spot conspires to impress the beholder with the idea of wild sublimity. The perpendicular fall of the water is of no great height; but the whole stream is here compressed into a channel of a few rods in width, worn out of solid granite, a quarter of a mile, or more, in length, down which the current dashes, as if impatient of its confinement in so narrow a bed; and at the foot

of the sluice, it spreads out again into its accustomed width and soon resumes its wonted calmness.

Near the middle of these Falls a bridge is thrown across the river, and from this, a fine view is afforded of the rapids and surrounding scenery. The first time I visited the spot, I chanced to cross this bridge from the east, as the evening twilight was dying away, and there was just indistinctness enough upon objects to leave room for the play of the imagination. In the middle of the bridge I stopped and looked into the foaming stream below, where the ragged rocks, half seen amid the partial darkness, jutting out from the banks and shooting up from the bottom, presented a real Charybdis, devouring whatever entered its jaws. Dangers enough were visible, in the dark waters below ; and while nothing but the bridge seemed to separate me from destruction, on looking up, I saw the venerable Fall mountain, rising with its impending precipices, and threatening to bury the whole in ruins.

Nearly a mile below the falls, on the Vermont side, is a favourable spot for viewing them and the surrounding scenery. From this point you see the cataract nearly in front, with the bridge crossing it at right angles, with the line of vision ; while the mountain, here seen in its whole length, forms a lofty mural barrier on the eastern bank. At the foot of this mountain, just beyond the bridge and almost overshadowed by the shaggy rocks, stands a large and elegant mansion house ; and on the opposite side appears a neat compact village.

Turner's Falls.

These cross the Connecticut, near the point where the towns of Greenfield, Gill and Montague meet. There is no distinctive name by which they are known in the vicinity ;*

* Professor Silliman denominates this cataract Miller's Falls (See Tour. to Quebec, p. 400.) But Miller's Falls are three miles higher up the river, at the mouth of Miller's river, and not in the Connecticut.

A few years since an Indian, who lived near Turner's falls, was precipitated over them : But by his dexterity in swimming, and by placing his feet forward as he descended, he escaped alive. Some time afterward, however, as the ice in the spring time was breaking up, he was unfortunately carried over among the broken fragments and never appeared again.

and I have ventured to denominate them Turner's Falls, for a reason that will appear in the course of the description.

The river at this place runs in a northwest direction, crossing the rock strata nearly at right angles; and an artificial dam is raised upon these rocks of the coal formation, so that the whole stream, which is here more than one thousand feet wide, falls thirty feet perpendicularly. This sheet of water, however, is divided near the middle by a small island on which the dam reposes. For three miles below the principal descent, the water continues to descend so as to render a canal necessary.

The proper and almost the only spot for viewing this cataract to advantage is on the elevated ground forty or fifty rods below the falls on the northeast shore.* Standing on this spot, you have the principal fall of water nearly in front, or at right angles with the line of sight; and you can see the river above and below the dam one or two miles. The contrast, is, however, very great. Above the cataract the water is unruffled to the very verge of the precipice, down which it rolls in graceful majesty. Below, it tumbles and foams among the rocks as far as the eye can trace it. A little farther down the stream than the station of the observer, the river strikes directly against a greenstone ridge,† two hundred feet high, by which it is forced to curve to the left, more than a quadrant, and afterwards runs nearly south. The rocky island that divides the cataract, with the white foam dashing against the base of its cliffs and its top crowned with a few pines and other shrubbery, is a picturesque addition to the scenery. Several rods below this island another is planted of similar aspect, but smaller, and at a much lower level, and apparently inaccessible. The upper island may be reached by a canoe in safety; and then we can descend to the very foot of the falls and find the voice drowned by their roar; and in favourable circumstances, see the rainbow arching over the falling sheet.

* From this spot a view of these falls was taken, in 1818, by a friend, and inserted in the Port Folio for December of that year, with a short description. The dam has recently been removed several rods down the stream; so that the present view differs a little from the drawing which was then executed; and the removal of the dam, I think, has rather injured the view.

† At the foot of this ridge, in the bottom of the stream, and adhering to the rocks, grows in abundance the singular *Lemania fluviatilis* of Agardh.

The country around these falls is little cultivated and there are but few settlements on either side of the river. In almost every direction you see gently rising hills, covered with trees; of which the pine forms a large proportion. For three miles above the falls is a fine spot for a sailing excursion. You immediately enter between wooded, and moderately elevated hills, exhibiting all their original wildness; and so placid is the stream, gently curving among these hills, now and then spreading out so as to form coves along the shore, and here and there chequered by small islands, that you fancy yourself to be in the midst of a romantic mountain lake. To the coves along the shore, parties frequently resort for taking fish.

These and other circumstances render Turner's falls and the vicinity an attractive spot to any one who takes an interest in the wild and sublime scenes of nature. By a reference to the preceding part of this sketch, it will be seen that the geologist and mineralogist will find here much to awaken and gratify curiosity.*

Bellows and Turner's falls are in many respects very dissimilar. At the former, the river is narrow and the fall, viewed by itself, is not the principal object of interest; but at the latter, the Connecticut pours a broad and unbroken sheet of water over a precipice comparatively lofty, producing a roar that is frequently heard at the distance of twelve miles.

One hundred and fifty six years ago, a party of Philip's Indians, having joined those residing in Hatfield, Deerfield, &c. all being at war with the white inhabitants, resorted to Turner's falls to take fish, and encamped on the north east shore. On the 17th of May, Capt. Turner from Boston, marched from Hatfield with one hundred and fifty men, consisting of the garrison and militia from Springfield, Northampton and Hatfield, and came by surprize upon the Indian camp the next morning at day light. The Indians were totally unprepared for the attack, and fled in every direction. Some sprang into their canoes, and pushing from the shore without paddles, were hurried over the cataract

* I am at a loss to account for it, that these falls have excited so little attention and drawn so few visitors. They are but three miles from the village of Greenfield, the road is good, and the accommodations decent, at a public house on the bank.

and dashed in pieces—while some reached the opposite bank. Three hundred Indians are said to have been killed and only one Englishman. Yet the Indians who survived, being joined by another party, fell upon the English troops as they were returning and made dreadful slaughter among them. So that before they reached Hatfield, Capt. Turner was killed, and thirty seven of his men.

After reading this piece of history, no one will doubt the propriety of denominating this cataract Turner's Falls.

Shelburne Falls.

These are in Deerfield River in the west part of Shelburne : and a partial description has already been given of them in this sketch. I know of nothing concerning these rapids that requires particular description. Visiting them at low water, however, I was much struck with the number and magnitude of those spheroidal excavations in the rock called *pot holes*. They are often seen several feet in diameter and depth, and the stones, &c. by which the water wears them out, are still found at their bottom.

PART IV.

Miscellanies.

The greater part of the subjects to be presented under this division might, without impropriety, have been connected with the first, or geological part. But as that division had swelled more than was expected, it was thought best to throw them together at the close of the Sketch. Some of the following articles however have suggested themselves since the geological part was written.

Ancient Lakes.

Any one who examines the passage of the Connecticut and many of its tributaries, through several mountains embraced by the Map accompanying this Sketch, will be led, I think, to the conclusion that the waters of this river once flowed over the great valley along its banks, forming an ex-

tensive lake: and also, that when this began to subside, by the wearing away of the outer barriers, other barriers would appear and produce other lakes of inferior extent.

It is no argument, as some have thought, in favour of such a supposition, that so much rock occurs in this basin which is evidently a recomposition of the detritus of older formations; and that organic remains are found in these rocks. For every geologist knows that all this must be referred to a period anterior to that, in which the last grand diluvian catastrophe happened to the globe and left our continents in their present form.* Nor is the mere occurrence of masses of stone, evidently rounded by the attrition of running water, any evidence in favour of this hypothesis; for we must look for the cause of this also, as far back at least as the Noachic deluge.—No current of water with which we are acquainted is sufficient to transport such masses of rock into the situations in which we find them: "for though we can readily conceive how the agency of violent currents may have driven these blocks down an inclined plane, or, if the *vis a tergo* were sufficient, along a level surface, or even up a very slight and gradual acclivity, it is impossible to ascribe to them the Sisyphean labour of rolling rocky masses, sometimes of many tons in weight, up the face of abrupt and high escarpments."† Rounded masses of rock may however occur under such circumstances as to show them to have been removed by currents posterior to the deluge.

The principal evidence in favour of the supposition that the waters of the Connecticut once flowed over the broad valley on its banks, consists in the appearance of the channel of the river where it passes through certain mountains. Thus, every one perceives that this river must have cut its deep passage through the mountains below Middletown: in other words, this supposition will account for that gulf several hundred feet deep in which this river now flows, and we are not acquainted with any other agency that will account for it. And if it be admitted that this passage was

* See some excellent remarks on this subject in the recent work of Conybeare and Philips, entitled "Outlines of the Geology of England and Wales"—page 57 Introduction.

† Vid. same work page 29, Introduction.

once closed up nearly to the general level of the neighbouring mountains, it must have thrown back the waters of the Connecticut over the whole of the secondary tract marked on the map, with the exception of some of the highest ridges and peaks of greenstone and sandstone, which then probably formed islands in this extensive expanse of waters.

At the outlet of the Connecticut through the mountains below Middletown, a little south of the Chatham cobalt mine, and six or seven hundred feet above the present bed of the river, I saw rounded masses of old red sandstone, several inches in diameter, mixed with the fragments of the rocks in place. Such a fact I never noticed at any other place in the primitive region along the river: certainly not on the east side of it. And I was led irresistibly to the conclusion, that they were conveyed thither by the ice of the ancient lake, which would be floated to the ocean through this outlet.

In the northern part of the tract supposed to have been covered by this lake, other evidences of its existence present themselves. In the southern part of Deerfield, the sandstone cliffs of Sugar Loaf, four hundred feet above the present level of the Connecticut, bear evident marks of having been worn and undermined by water:—that is, they appear very much like similar rocks which now form the beds and banks of the Deerfield and Connecticut rivers. In the north part of Deerfield, at the west foot of the greenstone ridge, and two hundred feet at least above the Connecticut, is the channel of a stream ten or twelve rods wide, that once ran *southerly*, as appears from the little eminences of greenstone that were exposed to its action, which present a perpendicular front on the north side, while the south side is sloping and presents an accumulation of broken pieces of the rock. One mile west from this spot, and a few rods south of the village of Greenfield, appears the bed of a smaller stream which there formed a cataract,* of a few feet over a ledge of red sandstone rocks. In this rock are numerous spheroidal excavations of two or three feet in depth, leaving no doubt that a current of water once flowed there. This channel is less than one hundred feet above

* See Dickinson's View of Massachusetts, p. 33.

the Connecticut. A little to the northeast and especially one or two miles northwest of the village of Greenfield, the old red sandstone rocks are smoothed and fluted in a great many instances; indicating a former exposure to currents of water. These various circumstances render it very probable that the country was once covered by a lake.

As the passage of the Connecticut through the mountains below Middletown was gradually worn deeper and deeper, this lake would be lowered also—and in process of time, the lofty greenstone ridge, extending from near New-Haven to Amherst, would present another barrier, and at length the original lake would be divided into two; the one extending from Northfield, on the west side of this ridge, nearly to New-Haven, and the other, on the east side, from South-Hadley to Middletown. There is every appearance that the Connecticut has worn down a passage through this ridge between Holyoke and Tom.

As this process of draining continued from century to century, these lakes constantly contracted their limits, until at length the greater part of the extensive vallies they occupied were laid bare. In the western lake however, were three basins, at Farmington, Westfield and Deerfield, a few miles in extent, which would remain filled with water until the three rivers of the same name, which supplied them, had worn away passages through the greenstone ridge above mentioned. That they have done this, will be doubted by no one who will examine their course through this mountain.

Thus after the lapse of years would these lakes all be drained, leaving a rich valley for cultivation. And whoever will examine the alluvium of Farmington, Westfield and Deerfield, will be led to suppose that the period when the work was finished could not have been many centuries before the settlement of this country.

Sunderland Cave.

This is about three miles northeast of the village in the rocks of the coal formation. It forms nearly a quarter of a circle, is about ten rods through, opens on the north and west, is from two to twenty feet wide, and from ten to sixty or seventy deep. A few rods to the south is a fissure ten feet wide, nearly parallel to the cave, and sixty or seventy

feet deep. Both the cave and the fissure are in an immense mass of pudding stone with scarcely any thing like stratification throughout ; and this is incumbent upon a soft, decomposable, argillaceous sandstone slate. The disintegration of this slate, either by the waters of the lake above described, or by simple exposure to the vicissitudes of the climate, has probably caused this enormous stratum of conglomerate to fall partially down and thus to form the cave and the fissure.

Favourable situation of Yale College as a School of Mineralogy and Geology.

It is a curious circumstance, that this Institution should have been fixed by its founders, who must have been altogether unacquainted with geology, at the very focus of most of the Wernerian rock formations. It stands at the southern extremity of the secondary region of the Connecticut; and had experienced geologists searched the whole of New-England, they could not have found a more eligible situation for a geological and mineralogical school. It is also a fortunate coincidence of favourable accidents, that the first mineral cabinet in the United States should have been deposited in Yale College, before there was much known concerning the interesting nature of the surrounding country.

The geological professor at Yale could, even from his lecture room,* point out most of the rock formations of the globe. He could direct the attention of his pupils to the plain around them, as alluvium ; and to the hills of Woodbridge and Milford, as exhibiting interesting deposites of diluvium. On the north they would see the striking secondary greenstone eminences of East and West Rock ; and on the west, hills of primitive greenstone. In this same direction, only four or five miles distant, he might point them to the West-Haven chlorite slate, to the Woodbridge argillite, to the Milford *verd antique* and serpentine, and a little beyond, to the mica slate. A few rods to the north, or east, they might see the old red sandstone and the green-

* The cabinet which is in the third story of a high building and in which the lectures are given commands a view of the neighbouring hills.

stone dikes they contain. In East-Haven, also, six miles distant, occur the red and grey slates of the Coal Formation; in Northford, the fetid carbonate of lime; at Southington the bituminous limestone; at Westfield the bituminous shale with ichthyolites; at Durham the coarse conglomerate of the coal formation, and at Berlin the greenstone and slates of the coal formation with interesting localities of coal, galena, blende, barytes, agates and zeolites in the greenstone—all within half a day's ride. In East-Haven appears the sea beaten granite; and, a little farther to the north and east, the gneiss, hornblende slate and mica slate formations.

The mineralogy of the vicinity of Yale, is also rich and diversified. Suffice it just to mention the chalcedony, carnelian, amethyst, agates, stilbite, zeolite, laumonite, prehnite, analcime, &c. of the neighbouring greenstone: the native copper, copper and lead ores, so abundant in the same formation:—the native silver, bismuth, magnetical and common pyrites, galena, blende, the three ores of tungsten, the tellurium, fluor spar, epidote, titanium, &c. of Huntington: the asbestus, bitter spar, sahlite, serpentine, &c. of Milford: the cobalt ores at Chatham; the corundum, andalusite,* &c. of Litchfield; and the chrysoberyl, beryl, tourmalines, garnets, magnetic iron, columbium, &c. of Haddam.

Geological Position of Amherst Collegiate Institution.

This is situated on elevated ground, and commands an extensive and delightful view af the surrounding country. It stands on granite, here covered by diluvium; but the granite appears a short distance both north and south. On the west, stretches out an alluvial plain; on the south, rises the lofty Holyoke of greenstone; on the east, of gradual ascent, a mountain of gneiss; on the north, appears, a few miles distant, mount Toby, composed of rocks of the coal formation; and also the rounded Sugar Loaf of old red sandstone:—while beyond the alluvial tract, on the west, rises a high range of mountains made up of granite and sienitic granite, (containing the interesting lead mine of South-

* Recently announced by Major Delafield. Vide Amer. Journ. Sci. Vol. 6. p. 176.

Hampton,) primitive greenstone, greenstone slate, mica slate and gneiss, so that without mentioning the rare minerals found in the vicinity, it is evident that an interesting assemblage of rocks is presented in the neighbourhood for the instruction of the geological student.

Fac Simile of Goshen Graphic Granite. [See Plate 1, Fig. 1.]

A description of this granite has been already given in the First Part of this Sketch. But having since discovered some more perfect specimens, I thought it might not be unacceptable to have one of them copied. It is not common to find specimens so well marked as the one from which the plate was taken ; yet, in general, they are quite handsome. The points, triangles, &c. of quartz, usually enlarge, or diminish, as they traverse the feldspar. Thus, the specimen, of which the plate is a copy, exhibited on its opposite side (about four inches distant from the surface that was copied,) the same characters but four times as large.

Pseudomorphous Granite. [See Plate 1, Fig. 2.]

It is not an easy matter to give a good graphic representation of this rock. Perhaps however, the one annexed may assist in understanding the description given on p. 17, [illegible]. The dark part represents the plates of mica ;—the red part the quartz, and the uncoloured portion, the feldspar. This rock occurs abundantly in Goshen, connected with the graphic granite above described ; and the transition of the one into the other is usually very sudden.

Lusus Naturae. [See Plate 1, Fig. 3.]

For a description of this, see page 15, [illegible]

Desiderata in the Geology and Mineralogy of the Connecticut.

It may be remarked in general, that but a small part of the geology and mineralogy of this region has been brought to that degree of perfection to which these sciences have been carried in some countries in Europe ; and, therefore,

there are desiderata in the whole. But some parts are more deficient than others ; and I shall take the liberty of noting some of those points which seem more particularly to demand the further attention of the geologist. Among these the following may be named.

1. A more exact determination, in many instances, of the boundaries of the several formations.

2. Further examination of the exact relative position of the old red sandstone and the coal formation.

3. Further search for greenstone dikes. not only in the old red sandstone, but also in the coal formation, and even in primitive rocks.

4. Whether the beds of secondary greenstone detach veins from one to the other, as in the isle of Sky.

5. A further examination of the granitic beds, to determine whether like connecting dikes or veins may not be found uniting them also.

6. A more thorough search to ascertain whether all our granite does not exist in the form of beds and veins.

7. To find more instances in which the coal formation and greenstone form alternating beds.

8. An examination of the beds of clay and gravel, found along the Connecticut, for shells and other organic remains.

9. Further search in the coal formation for organic remains.*

10. Examination of the bituminous limestone of Southington, especially with the query of Prof. Silliman in mind, (Journal p. 63, vol. 6.) whether this rock may not itself be, or be connected with, bituminous marl slate ?

11. The extensive range of greenstone, running from Berlin to Amherst has as yet been but little examined for minerals, as well as many other greenstone ridges. Indeed, the mineralogy of this whole region requires farther exploration, and promises the diligent student much fruit.

Meteorological Fact.

The following circumstance, although connected with geology, does not strictly come within the limits of this

* Dr. Cooley informs me that he has recently discovered another locality of ichthyolites in Deerfield, about three miles from the locality in Sunderland.

Sketch : Yet it seems worth noticing, but hardly of sufficient importance to form a separate paper.

In going westward from Connecticut river, we first pass over an alluvial tract and then continue gradually to ascend, for twenty miles, to the top of Green and Hoosak mountains. As might be expected, the winters on this elevated land continue two or three weeks later than in the valley ; that is, the farmer can sow his seeds two or three weeks earlier in the valley than on the hills. But in autumn, the destructive frosts are usually as much later on the hills than along the river :—so that one frequently passes from the river in October, where almost every vegetable is destroyed, and finds the crops uninjured on these hills ; and the crops there are about a fortnight later than those in the vallies, so as to require this lengthening out of their time of ripening. I have been disposed to attribute this fact to the greater moisture of the atmosphere of the vallies, arising from the more copious exhalations from the river, whereby the effects of frost are greatly increased, even at the same temperature.

*Tabular Arrangement of the Rock Formations along the Connecticut.**

* I here follow with pleasure the very simple yet ingenious arrangement of rocks, which is adopted by Conybeare and Phillips, as the basis of their recent work on the Geology of England and Wales. It has the rare merit of being entirely free from hypothesis. It would be well if a similar purification from the alloy of uncertain systems, could be extended through every part of geology. The work, however, is rapidly advancing and in the hands of such men as the authors of this work, and of Mc Culloch, Greenough, Buckland, Webster, Borrè, Cuvier, Brongniart, &c. we confidently expect that it will be speedily accomplished.

In the above table, I may have put down some rocks in the Inferior Order, which the authors of this arrangement will place in the Submedial Order. For their account of these orders is not yet published ; and in the general sketch, they have given, only a part of the rocks belonging to each order are enumerated.

I. Inferior Order.

Mutually Interstratified and without any regular order of succession.

		Rocks observed in contact with those in the leading column.	
1. Granite. Common, Porphyritic, Graphic, Pseudomorphous	Sienitic Granite	N. Hampton, Belchert'n, &c.
	Gneiss	Leverett granitic range,
	Hornblende Slate	Do. Granville, &c.
	Mica Slate	Conway, Williamsburgh, &c.
	Serpentine	Westfield, Mass.
	Limestone, (No. 7.)	Conway
	Diluvium	Passim
	Alluvium	Northampton
2. Sienite, or Sienitic Granite.*	Granite	Northampton, &c.
	Hornblende Slate	Chatham.
	Primitive Greenstone	Whately.
	Diluvium	Do.
	Alluvium	Northampton.
3. Gneiss. Common, Glandulous	Granite	Leverett, &c.
	Hornblende Slate	Passim.
	White Gran. Limestone	Litchfield County.
	Mica Slate	Leverett, Granville,
	Steatite	New-Salem. [&c.
	Diluvium	Passim.
4. Hornblende Slate	Granite	Granville, &c.
	Sienitic Granite	Chatham.
	Gneiss	Passim
	Mica Slate	Shelburne, Colerain, &c.
	Diluvium	Passim.
5. Mica Slate	Granite	Conway, &c.
	Gneiss	Monson, Wilbraham, &c.
	Hornblende Slate	Shelburne, Heath, &c.
	Limestone, (No. 7)	Deerfield, Conway, &c.
	Argillite	Leyden, Woodbridge, &c.
	Chlorite Slate	Whitingham, Milford
	Greenstone Slate	Whately, Do.
	Serpentine	Middlefield.
	Steatite	New-Fane, &c.
	Old Red Sandstone	Passim.
	Coal Formation	S. Hampton Lead Mine.
	Diluvium	Passim.
	Alluvium	Wilbraham.
6. Talcous Slate	Mica Slate	Plainfield, Hawley, &c,
	Chlorite Slate	Whitingham.
7. Limestone, or a Granitic Aggregate of Silex, Carb. Lime and Mica	Granite (in veins)	Conway.
	Mica Slate	Deerfield, &c.
	Argillite	Putney.

* This is undoubtedly the rock denominated sienitic granite, by Dr. Mc Culloch, in his Geology of Glen Tilt. (Geol. Trans. Vol. 3. p. 299 and 300.) That is, he regards it as a mere variety of granite, distinguished from other varieties by the presence of hornblende in any proportion. Had I read his memoir on the Tilt before the geological part of this sketch was written, I should not have separated sienite from granite, but have treated the two rocks as mere varieties.

Rocks observed in contact with those in the leading column.

8. Chlorite Slate	Talcous Slate	Whitingham.
	Mica Slate	Do.
	Argillite	Guilford, Vt. and Woodbridge.
	Verd Antique	Milford.
	Prim. Greenstone	Do.
	Diluvium	Do.
	Alluvium	Orange, (Ct.)
9. Steatite	Gneiss	New-Salem.
	Mica Slate	Middlefield.
	Serpentine	Do.
10. Serpentine	Granite	Westfield, Mass. (Eaton.)
	Mica Slate	Middlefield, (Dewey.)
	Granular Limestone	Milford.
	Steatite	Middlefield, (Do.)
11. Verd Antique	Primitive Greenstone	Milford.
	Chlorite Slate	Do.
12. Primitive Greenstone	Unstratified	Mica Slate — Wolcott?
		Chlorite Slate — Milford.
		Sienite — Whately.
	Greenstone Slate	Verd Antique — Milford.
		Old Red Sandstone — Whately, Gill.
		Coal Formation — Gill, Northfield.

The order of succession of the seven preceding rocks is very variable and uncertain.

II. Submedial Order.

13. Argillite	Mica Slate	Putney, Woodbridge.
	Limestone, (No. 7.)	Do.
	Prim. Greenstone	Woodbridge.
	Chlorite Slate	Do.
	Old Red Sandstone	Do.
	Diluvium	Do.
	Alluvium	Brattleborough.

III. Medial Order.

14. Old Red Sandstone	Common / Conglomerated	Granite — Northampton.
		Mica Slate — Deerfield.
		Argillite
		Prim. Greenstone
		Second. Greenstone
		Coal Formation
		Diluvium
		Alluvium

			Rocks observed in contact with those in the leading column.	
Interstratified.	15. Coal Formation.†	Wacke*	Granite	Southampton?
		Trap Tuff	Gneiss	Montague.
		Dark bastard Limestone	Mica Slate	S. H. lead m.
		Bituminous Do.	Old RedSandstone	Passim.
		Fetid Do.	Prim. Greenstone	Gill.
		Seams of Coal	Sec. Greenstone	Passim.
		Fine red arg. Sandstone	Diluvium	Do.
		Coarse gray Siliceous Do.	Alluvium	Enfield, (Ct.)
		Very Micaceous Do.		
		Black tortuous Do.		
		Bituminous Shale		
		Finer Puddingstone		
		Coarse Do.		
	16. Secondary Greenstone	Compact	Granite	East-Haven?
		Columnar	Old Red Sandstone	East and West Rock.
		Amygdaloidal	Coal Formation	Gill, Berlin, &c.
		Porphyritic		

IV. Superior Order.

17. Diluvium - -		Above most or all of the preceding formations.
18. Alluvium.	Oceanic deposites	Above most of the preceding formations.
	Beds of Gravel	
	Do. Clay	
	Do. Sand	
	Loam	
	Decomposed Rocks and Vegetables	

* Prof. Silliman has decided, in the affirmative, the question whether this rock exists along the Connecticut. Vide Journal of Science, Vol. 6. p. 51 note.

† In Conybeare and Phillips' late interesting work on the Geology of England and Wales, (p. 311,) the Bituminous Marle Slate, with the accompanying limestones, sandstones and conglomerates, is placed in the supermedial order; that is, immediately above the rocks of the coal Formation; and if the Rocks above denominated the Coal Formation should prove to belong to the Bituminous Marlite Formation, according to Mr. Brongniart's opinions, they must be placed in the Supermedial order also. But what becomes of the old red sandstone (rothe todte liegende) which lies immediately below the Bituminous Marl Formation in Germany, and below the coal formation in England? These writers (or rather Rev. W. D. Conybeare, who wrote the article here referred to) regard the rothe todte liegende of the Germans, as distinct from the old red sandstone of England. *Query*—if the rocks along the Connecticut are really the coal formation of Europe, may not the red sandstone east of the river in Chatham, East-Hartford, Windsor, &c. be the rothe todte leigende; and that west of the river the old red sandstone of England?

This same writer, speaking of the real coal formation, says that "at least ten characters will be found in common between the carboniferous

P. S. *Coal Formation.*

Since the publication of the description of this series of rocks along the Connecticut, I have had an opportunity to examine more extensively than I had done before, the coal formation of Rhode-Island; and thus to institute a comparison between the two. And I feel satisfied that they are very distinct from each other; and that the Rhode-Island formation is the oldest. There is a sort of general difference between them, which is readily recognized by the eye, but which it is not easy to describe. In the Rhode-Island rocks, however, there is a greater resemblance, in the general aspect and in the fracture, to primitive rocks than in those of the Connecticut; and the former are, in general, harder and more compact than the latter; and their cement is more argillaceous. The coarse puddingstone, so abundant in Roxbury, Dorchester, &c. and which is seen at intervals most of the distance to the anthracite beds in Portsmouth, approaches, in certain varieties, very near a similar rock in Montague, Sunderland, Durham, &c. In the first named rock, however, the cement is rather more abundant, and the rock, as Maclure very happily expresses it, "has the appearance as if the cement at the time of formation had a consistence sufficient to prevent the particles from touching each other." Certain fine red and coarse gray slates occur in the two formations which can hardly be distinguished, except that those in Rhode-Island (as well as most of the other transition rocks there,) are traversed by veins of quartz, but those on the Connecticut never are.

I would not be understood as endeavouring to prove that the Rhode-Island formation belongs to the Wernerian transtion class and that of the Connecticut to the secondary. Both probably are transition; yet the one may lay claim to a greater age than the other.

and transition class (of Werner) for one which could lead to an opposite arrangement"—that is with the fleetz class, and also "that the sandstones of the lower part of this series approach closely in character to the more obviously mechanical varieties of greywacke, and indeed so completely pass into that rock, that in many instances the limits between this series and that of transition rocks, can only be arbitrarily assigned."—(pp. 323 and 324.)

Gneiss.

The more I examine the rocks in New-England, the better convinced I am that the extent of this rock in this region, has been overrated by geologists. The truth is, that almost in every place which I have examined, mica slate alternates with gneiss, or overlies it, so as to occupy nearly, sometimes more than half the surface. Hornblende slate and granite, also occur in the same series. In passing from Northampton to Boston, I have never found any gneiss east of Worcester; although in going from Providence to Hartford, this stratum occurs only twelve miles from the former place and continues with alternations of mica slate, &c. to within a few miles of the latter place.

I cannot avoid remarking here, that wherever I have seen beds and veins of granite in gneiss and mica slate, I have usually found the strata much distorted and deranged in the vicinity; and *vice versa*, where derangement of the slate appeared, I have generally been able to discover veins or beds of granite. And wherever granite veins exist, granite beds are not usually far off. I might say more on this subject: But it has only recently attracted my particular attention, therefore I desist. I am satisfied, however, that many of the phenomena of Glen Tilt are repeated in New-England.

Greenstone—primitive—transition and secondary.

The second supposed distinction between the primitive and secondary greenstone of the Connecticut is very imperfectly stated page 32 vol. 6. The mere fact that the primitive greenstone forms beds in other rocks does not distinguish it from secondary greenstone; since this occurs in the same situation. But the former, at the sides of the bed, passes by imperceptible gradations into other rocks, such as greenstone slate, chlorite slate, &c. thus excluding the idea that it could have been forced in between the strata of other rocks after their consolidation: whereas the latter rock is distinctly characterized to the very line of junction with the sandstones and puddingstones, unless there be a slight chemical change a few inches on either side of this line, as if by heat.

It may not be amiss to state here that the greenstone of the Connecticut has a very different aspect internally and externally from the epidotic and sienitic greenstones in the vicinity of Boston. The latter are evidently transition, being associated with the sienite, porphyry, gray wacke, argillite, &c. But I am not prepared to state precisely in what respects they differ from the greenstone of the Connecticut.

And although it does not strictly belong to this place, it may not be amiss to refer to the interesting dykes of basaltiform greenstone occurring in sienitic granite in the vicinity of Boston, of which I do not recollect to have seen an account. I have noticed them in Sudbury and Weymouth in real granite—that is, the rock was destitute, at the place of hornblende. One in Weymouth, or perhaps in Braintree, I traced several rods, and it retained its width with mathematical exactness, and the sides were perfectly smooth. These dykes deserve more examination and better description. Perhaps some of them contain real basalt.

White Augite.

Since writing the account of this mineral found in Goshen, which occurs on page 225 vol. 6. I have visited the locality again, and find it in immense abundance. About two miles north of Goshen meeting house, a few rods beyond a tavern on the west side of the road, is a pasture almost covered by bowlders of granite. These bowlders are full of augite, some of the crystals of which are from twelve to eighteen inches long and three or four wide, although they are very imperfect. Every cabinet in the world might be supplied from them. I noticed also in the same rock some crystals of beryl more than an inch in diameter.

Precious Garnet.

This occurs abundantly in gneiss in west and south Brookfield. Some are an inch diameter; their colour is light poppy red, and it is rare to find any exhibiting the form of the crystal distinctly, so that perhaps they ought to be referred to pyrope.

Prismatic Mica

Found in the northern part of Williamsburg in granite. Good specimens may thence be obtained.

The annexed drawings are from the same plates, as those inserted in Vols. 6 and 7 of the American Journal of Science. And it so happens, that a few figures, not belonging to this Sketch, could not be omitted. Among these, is a new species of Botrychium, found in Conway, and fully described in Vol. 6. p. 103 of Journ. Science. It was thought, that it might not be unacceptable, to insert the following short description of this plant, in this place.

Specific Character.

Botrychium Simplex: Frond simple, 3 lobed, or 3 cleft; segments unequal; spike sub-compound, interrupted, unilateral, bearing sessile capsules, in the last part of June, of the size of a mustard seed. Nearly allied to *B. Lunaria* of Europe: but it differs, in having a simple leaf, a spike hardly compound, and much larger capsules. In a dry, hilly pasture, a few rods south of the residence of Col. Charles E. Billings, in Conway.

Corrigenda.

The author of the preceding Sketch had not an opportunity to examine the proof sheets, and a considerable number of errors have been found, particularly in the first Part. Those, however, affecting the sense, have been corrected by the pen, in the few copies, that have been printed in this form

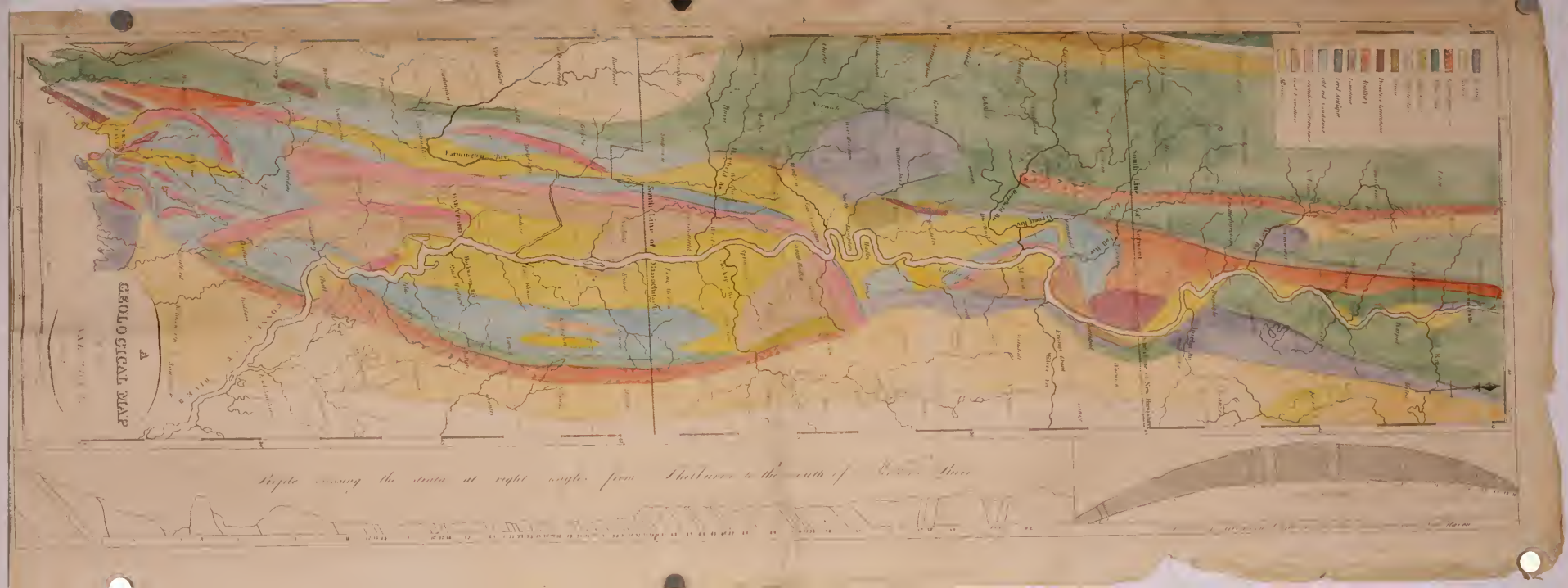
It is but justice to himself, also, for the writer to remark, that a pressure of more important duties has prevented him from giving that attention, in the preceding Sketch, to the graces of composition, which would have been desirable. He had been for several years collecting facts, relating to the Geology, &c. of the Connecticut; and the alternative seemed to be before him, either to abandon them to oblivion, or to publish them in the rather imperfect form in which they are presented in the preceding pages. He has chosen the latter course; whether wisely, or not, it is not for him to decide. He will be satisfied, if the facts exhibited should render any service to a science, which has recently assumed so interesting a relation to revealed religion.

The term *stratification* has been used in the geological part of the preceding Sketch, in a few instances where most geologists would probably have employed *schistose or slaty*. Some remarks of Greenough, in his work on the First Principles of Geology, led to this blending of the terms.

The term *alluvial*, in the preceding Sketch, is employed in the same sense, in which it is used by all American writers.

But, in Europe, it has recently been very much restricted in its signification. According to this limited view, but very little, that is marked on the accompanying map as alluvion, is really such; only a few small basins, as that of Farmington, Westfield, Deerfield and Northampton, which are annually overflowed by rivers. The remainder corresponds, probably, to some one of the older European formations: perhaps to the London clay.


Middletown
Meriden
Waterbury
Wallingford
Durham
Haddam
East Haddam
Colchester
CONNECTICUT
RIVER
Woodbridge
New Haven
Guilford
Killingworth
Saybrook
Branford
NEW HAVEN
East Haven
Orange
Milford
Derby
A
GEOLOGICAL MAP
of the
CONNECTICUT.
1822.
Scale of Miles
1 2 3 4 5 10 15 20 25
5' 73° 50' 40' 30
Profile
Engraved by A. Doolittle


GEOLOGICAL MAP
Profile showing the strata at right angles from Shelburne to the south of Green River

Mr Orr's figures PLATE 9.

1. pa. 134

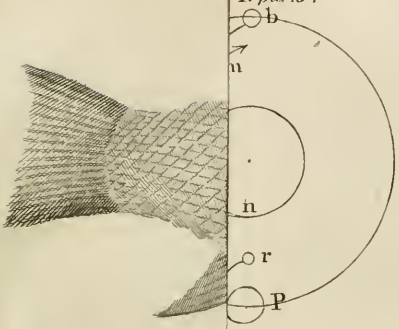


Fig. 3. pa. 140.

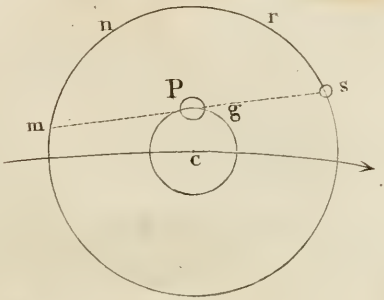
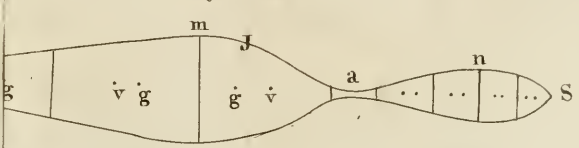
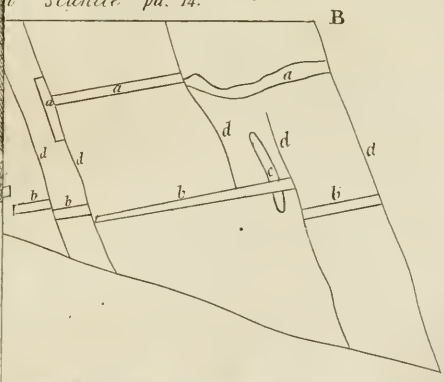
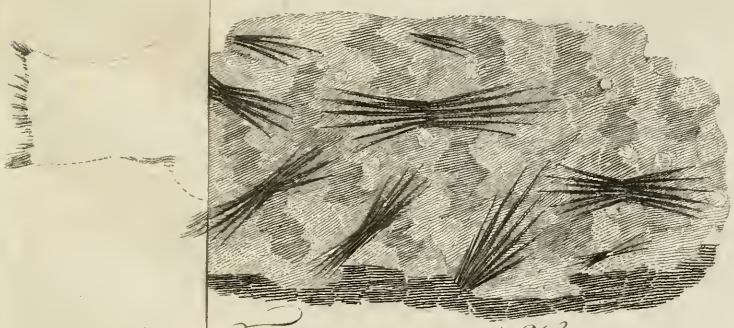


Fig. 2. pa. 137.



1. Scienite pa. 14.





Fasciculite of Mr Hitchcock.

Ichthyolites & Vegetable Remains

Fig. 1 pa 77

Fig 4 pa 80

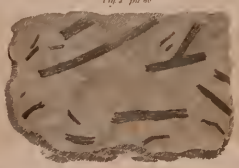


Fig 2 pa 77

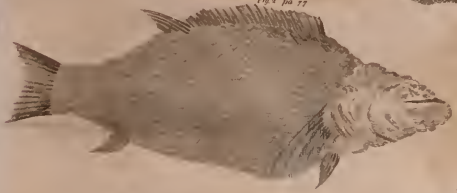


Fig 5 pa 78

Fig 5. pa 86.

Fig 1 pa 104

Fig 2 pa 104

Fig 3 pa 104

Fig 4 pa 104

Mr Orr's figures

fig 1. pa 134

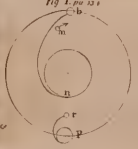


Fig 3 pa 10

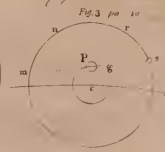
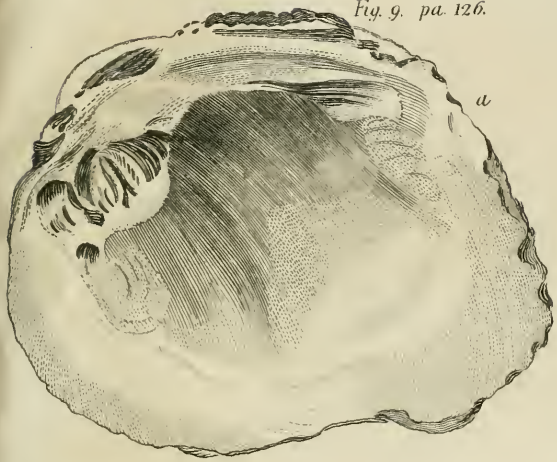


Fig 2. pa 137

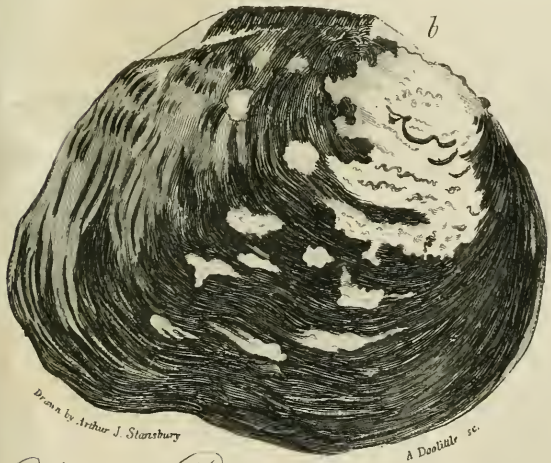
Granite vein in Limestone pa 14

Ulmea of D. Torrey — 104 Fasciculite of Mr Hitchcock

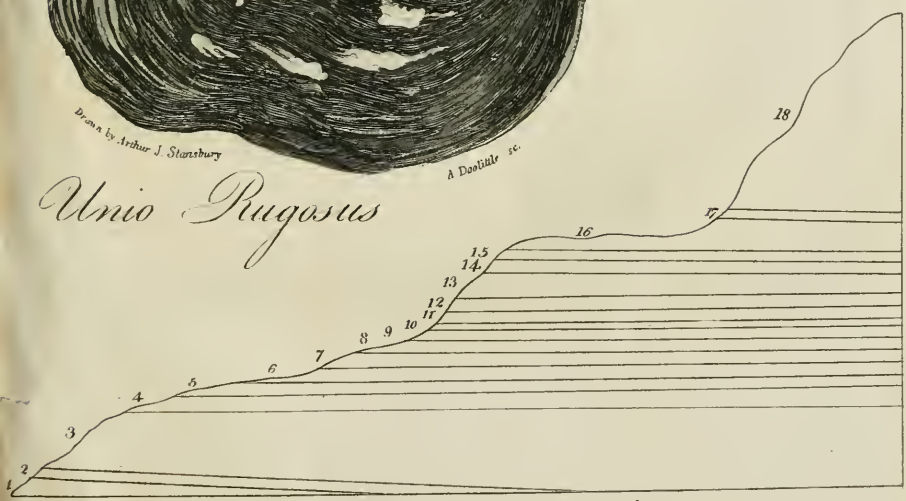
Fig. 9. pa. 126.



Botrychium Simplex pa. 103.

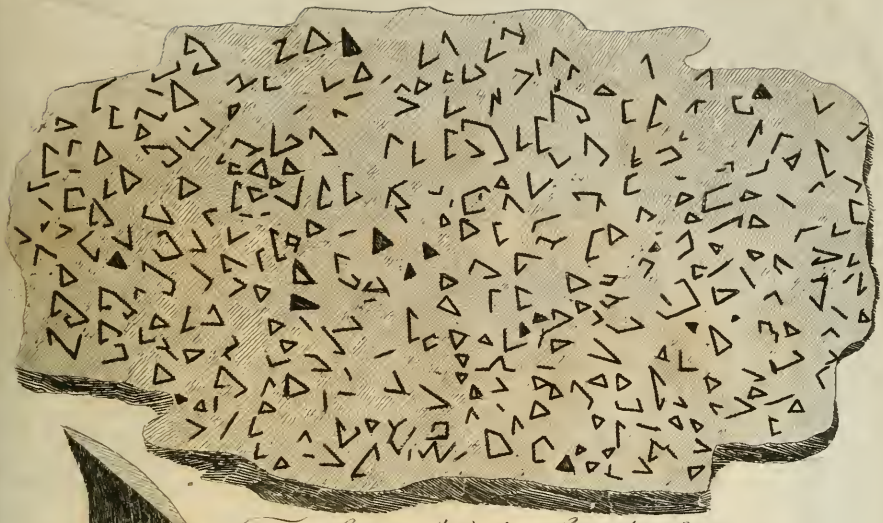


Unio Rugosus



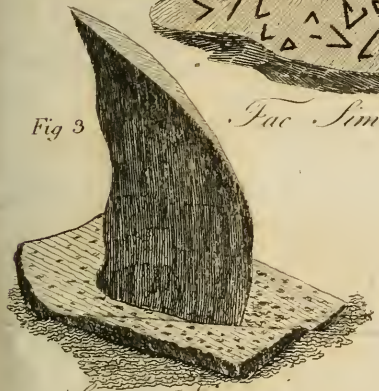
Section of Mount Toby & the strata beneath pa. 78.

Fig. 1.



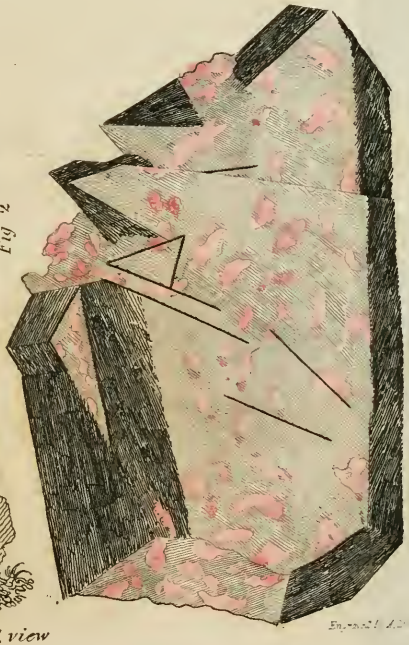
Fac Simile of Goshen Graphic Granite.

Fig 3



Lusus Naturæ.

Fig 2



Pendemsphœus Granit.

Fig. 4.

Roxbury Rocking Stone. N.E. view